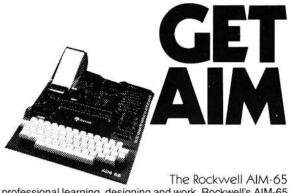
# COMPUTETM COMPUTETM





For professional learning, designing and work, Rockwell's AIM-65 microcomputer gives you an easy, inexpensive headstart! The AIM's full-size keyboard, true alpha-numeric display and on-board printer give you all of the peripherals associated with a large development system, yet AIM is priced lower than the first circuit board would cost for such a system.

4K AIM-65

\$515.00

AIM Enclosure

\$43.50

Protects the AIM 65 from damage while maintaining convenient access to on-board switches and printer.

Power Supply for the AIM 65 by MTU

This power supply from Micro Technology Unlimited provides the power and cooling capacity needed to run your AIM at peak efficiency.

Written by microsoft, Rockwell AIM-65 8K BASIC is contained in two easy-to-install ROM circuits.

AIM-65 Assembler ROM

\$85.00

Just plug it into the AIM 65 board and your AIM is ready to do all the busy work of creating 6502 Machine-Language programs.

CompuMart's Complete AIM-65 System. Save \$28

\$850.00

Includes a 4K AIM 65 with BASIC and Assembler, an MTU power supply, Sanyo tape recorder and enclosure.

Rockwell Motherboard for the AIM

Want to expand your AIM and keep Rockwell quality? Purchase the Motherboard from CompuMart.

\$179.00

From MOS Technology, a division of Commodore. This famous single board based computer comes to you fully assembled and testedsimply attach a power supply and you're ready to start computing. Includes three informative manuals FREE.

Micro Technology Power Supply

The perfect mate for a small KIM system. Comes fully assembled, tested, and enclosed in a Bakelite Box.

KIM 1 with power supply

\$204.00

Save \$10 when purchased together!

KIM Enclosure

\$23.50

Give your KIM-1 a professional appearance and protect it from shorts and physical damage.

Current Loop/IRS-232 Adaptor

\$24.50

For general interfacing applications. (KIM-1 to printer, KIM-1 to

modem, etc.)

Sanyo Cassette Recorder

\$55.00

Perfect for your KIM. Works great.

Books on KIM. (The following three books are included FREE when you buy a KIM. You may purchase them separately however).

6502 Programming Manual 6502 Hardware Manual

\$9.95 \$9.95

KIM User Manual

\$9.95

First Book of KIM

\$8.95

Buy direct from CompuMart and get more than you pay for.



270 THIRD STREET, COMPUMART CAMBRIDGE, MA. 02142

Write Dept. 317 for Free Catalog

In Mass. 617-491-2700

6502 SOFTWARE DESIGN

COMPUTER GRAPHICS PRIMER

Leo Scanlon—a leading computer expert—simplifies software design. Takes you from fundamentals into more complex topics. Get more versatility out of your computer by learning to program it yourself. IN-CLUDES 89 TEST PROGRAMS! NO. 21656. \$10,50

Mitchell Waite—one of the most popular computer authors—brings computer graphics into sharp focus. Shows you how to use a 6502-based computer to create complex drawings, plans, maps and schematics on a video screen. NO. 21650. \$12.95

PROGRAMMING
8 INTERFACING
THE 6502 •••••• HOWARD W. SAMS & CO., INC. 4300 West 62nd Street, PO. Box 7092 Indianapolis, Indiana 46206 (317) 298-5400 Indicate quantity in boxes above and complete ordering information below. Return entire ad with order. Total amount of order Add local sales tax where applicable PAYMENT ENCLOSED (Save postage and GRAND TOTAL handling costs)

CHECK MONEY ORDER MASTER CHARGE VISA Expiration Date Interbank Number (Master Charge only) Account Number\_ Minimum credit card purchase \$10.00 Signature. Address\_ Zip Prices subject to change without notice. All books ovailable from Sams Distributors. Bookstores and Computer Stores. Offer good in U.S. only. In Canada, contact Lenbrook Industries, Ltd., Scarborough, M1H, Ontario, Canada. COMPUTER CRAPHICS PRIMER **OUT OF YOUR** Sams has three books written especially for the popular 6502-based microcomputers like the APPLE, PET, ATARI, OSI, SYM, AIM and KIM. If you own a 6502-based computer—or are thinking about buying one—let Sams help you get the most out of the make graphics, programming, interfacing and software design simple. PROGRAMMING & INTERFACING THE 6502, WITH EXPERIMENTS. By Marvin De Jong. The more you know about programming and interfacing, the more performance you can get out of your microcomputer. This hands-on guide to 6502 presents 80 carefully graded experiments to help you get the most out of your AIM, KIM or SYM. NO. 21651. \$13.95

Sams

# **Table of Contents**

The Editor's Notes
The Single-Board 6502 Eric Rehnke, 4
Evaluation: The First Mate/Second Mate Marvin L. DeJong, 12
Nuts and Volts No. 3: Address Decoding Gene Zumchak, 15
A Simple Interface for a Stepper Motor Marvin L. DeJong, 18
Get Rich Quick
KIM-1 Tidbits
SYM-1 Home Warning System A.M. MacKay, 26
A Digital Cardiotachometer Implemented With The AIM-65 Marvin L. DeJong, 32
Saving Data Matrices With Your SYM-1 George Wells, 36
OSI ROMs: Part 1
Book Review: All About OSI Microsoft
Basic-In-ROM Charles Stanford 41
Basic-In-ROM
Modification and Relocation of FOCAL 65-E
Into Erasible PROMWilliam C. Clements, Jr., 48
COSMAC Quickies Jess Hillman, 50
The 1802 Instruction Set
CAPUTE: The Bug Box
300 CONTROL CO
Advertisers Index
Aardvark Technical Services
AB Computers
Applied Business Computer Co35
Beta Computer Devices
Compas Microsystems
CompumartIFC
Compute's Book Corner27
Connecticut Microcomputer30,31
Digital Engineering Associates14
Electronic Specialists
Enclosures Group
Excert, Inc
Falk-Baker Associates
Forethought Products
Hudson Digital Electronics
Howard Sams Co.
Micromate
Microtech
Michael Allen
Michael Allen
Perry Peripherals
Rehnke Software Enterprises
RNB Enterprises
Skyles Electric Works
T.T.I

### Staff of compute II.:

Robert C. Lock, Editor/Publisher Carol Holmquist Lock, Circulation Manager. Larry Isaacs, Software/Hardware Lab. Joretta Klepfer, Editorial Assistant.

compute II. receives continuing assistance from the following persons:

Harvey B. Herman, University of North Carolina at Greensboro, Dept. of Chemistry. Editorial Assistance. Gary Dean, The Design Group, Greensboro, N.C., Art Direction/Design Consultation.

Iim Butterfield, Toronto. Editorial Assistance.

The following writers contribute on a regular basis as columnists:

Eric Rehnke, 1067 Jadestone Lane, Corona, CA, 97120. Associate Editor

Dann McCreary, Box 16435-Y, San Diego, CA, 92116. Gene Zumchak, 1700 Niagara Street, Buffalo, NY, 14207

Application to mail at controlled circulation postage rate is pending at Greensboro, North Carolina. Postmaster: Send change of address to compute II, Post Office Box 5406, Greensboro, NC 27403.

compute II. is published by Small System Services, Inc., 900-902 Spring Garden Street, Greensboro, North Carolina 27403. Telephone: (919) 272-4867. compute II. is published six times each year on a bimonthly schedule. Subscription cost for one year is \$9.00. compute II. is available by subscription or through retail dealer sales. Subscription prices higher outside the US. (See below)

Address all manuscripts and correspondence to compute II. Post Office Box 5406, Greensboro, N.C. 27403. Materials (advertising art work, hardware, etc.) should be addressed to compute II., 900 Spring Garden Street, Greensboro, N.C. 27403.

Entire contents copyright © 1980 by Small System Services. Inc. All rights reserved, "compute II. The Single-Board COMPUTE." is a trademark of Small System Services, Inc.

compute II. assumes no liability for errors in articles or advertisements. Opinions expressed by authors are not necessarily those of compute II.

Authors of manuscripts warrant that all materials submitted to compute II. are original materials with full ownership rights resident in said authors. By submitting articles to compute II. authors acknowledge that such materials, upon acceptance for publication, become the exclusive property of Small System Services, Inc. Unsolicited manuscripts not accepted for publication by compute II. will be returned if author provides a self-addressed, stamped envelope. Program listings should be provided in printed form as well as machine readable form. Articles should be furnished as typed copy with double spacing. Each page of your article should bear the title of the article, date and name of the author.

Address all articles, circulation questions and other inquiries to: compute II.
P.O. Box 5406
Greensboro, NC 27403
(919) 272-4867

Robert Lock

Publisher/Editor

# The Editor's Notes IMPORTANT ANNOUNCEMENT!

COMPUTE and compute II are merging into one, high quality,

This is the last issue of **compute II.** Your next magazine, **COMPUTE!**, will arrive in November.

# The Timetable

monthly magazine.

The merger is effective with the November/December issue of **COMPUTE!** In January, we're monthly! Each month you'll receive the same quality of single board information we've been providing in **compute II.** 

# **Don't Despair!**

New **COMPUTE!** will contain a healthy Single-Board Computer Gazette, continuing to provide you with useful, up-to-date information. We're committed to continuing to provide as much or more information in two monthly issues as we've been providing in one bimonthly issue.

# **OSI Moves Out**

New **COMPUTE!** will have an OSI Gazette for you OSI owners, with the Single-Board Computer Gazette devoting its space to KIM, SYM and AIM.

# And What About the 1802?

Dann McCreary will continue his column, emphasizing the areas of communication between the 65O2 and the 18O2.

That's the new **COMPUTE!** Your subscription will be adjusted to make sure you get your six issues of **compute!**/COMPUTE! We'll explain the process in Issue 7 of **COMPUTE!** (November/December: the copy you'll receive next time.)

# The Single-Board 6502 Eric Rehnke

Well, I finally did it. Got myself an APPLE II to play with. No, I'm not abandoning KIM. Just wanted to see what all the hullaballoo was about.

Sure is easier to demonstrate than KIM. Who wants to see an assembler when they can see some neat video-arcade like games in action?

### ...And Ever The Twain Shall Meet

While I was preparing to take an AIM 65 system to the local computer club for a demo, it became painfully obvious that I would either have to build a special version of the sound generator board for my AIM 65/MTU system or, somehow, adapt the sound board that was built for my KIM-1/HDE system. I decided to adapt rather than fight with a new board from the ground up. Luckily, in my MTU card cage, the bottom row of slots are not used because of the way the MTU backplane board has been raised to accomodate the AIM 65. Also, the spacing between the card guide on the right hand side of the cage and the edge connector turned out to be just perfect for supporting the 4.5"x6.0" HDE size card. It was almost like the cage was designed to accomodate the standard 4.5"x6.0" size prototyping cards. (Keep this in mind when you need a quick and cheap proto board in your MTU system as they can be obtained for less than \$10).

Interestingly, a week later, I needed to adapt an MTU card (the Visible Memory graphics board) to my KIM-1/HDE system. Because of the size of the Visible Memory card it had to be mounted outside the HDE cage. A cheap 4.5"x6.0" proto board was installed in the HDE system with ribbon cable to extend the bus out to a 44-pin card edge connector which plugged on to the MTU card.

Both transplants are doing fine, thank you. And, on nights off from doing serious development work, big KIM can relax with some pleasing graphics as well as some interesting sound effects.

Here's how to cross pollinate your own system:

	SIGNAL NAME	
BACKPLANE		BACKPLANE
В	AB0	A
C	AB1	B
	AB2	
E	AB3	D
F	AB4	E
	AB5	
J	AB6	Н
K	AB7	J
	AB8	
	AB9	
	AB10	
P	AB11	N
	AB12	
	AB13	
T	AB14	S
	AB15	
	DB7	
9	DB6	9
	DB5	
	DB4	
	DB3	
13	DB2	13
	DB1	
	DB0	
	+ 8	
	GND	
	RES	
	02	
	+ 16	
W	R/W	v

Signal Conversion Table

### Sound Chip Driver

As promised, here is the low level driver software for interfacing a 6522 VIA to the General Instruments AY3-8910 Programmable Sound Generator (PSG). The explosion routine is included to satisfy yourself that the interface works correctly. The clock circuit was duplicated from page 33 of the PSG manual.

The 1 MHZ system clock (01 or 02) could have been used to save a few dollars but then all example values given in the documentation would have to be recalculated. Building the suggested clock input circuitry seemed to be the easier of the two alternatives since I had the parts on hand anyway.

The audio output circuitry was duplicated from page 6 of the PSG manual and used to feed one of the cheap (under \$10) Radio Shack speaker/amplifiers.

Connections from the 6522 to the PSG are similar to the scheme presented on page 43 of the PSG manual except that BC2 (pin 28) is connected to +5 volts (not PB1), and BDIR (pin 27) is connected to PB1 (not PB2).

This way, three additional PSG chips can be connected to the 6522 as my drawing indicated in issue #3 of COMPUTE (page 104).

I should mention that there was one thing about the PSG manual that really messed me up for awhile. All the register numbers and values are expressed in octal! Once I realized this, programming the chip went much easier.

OK. I've shown you how to hook up this neat chip and even threw in some software to get you going. What kinds of interesting sounds can you come up with? Can you program wind chimes or bells? I'll publish any neat sound programs.

```
SOUND CHIP DRIVER PROGRAM
         2000
01-0020
                             WRITTEN BY ERIC C. REHNKE
         2000
01-0025
         2000
01-0030
                             $6522 DEFINITIONS
         2000
01-0040
         2000
01-0050
                                                       $0810
                             IOBASE =
         2000
01-0060
         2000
01-0070
                             ORB
                                    =IOBASE
         2000
01-0080
                                    =IOBASE+2
                             DDRB
01-0090
         2000
                             DDRA
                                    =IOBASE+3
         2000
01-0100
                                    =IOBASE+15
                             OREGA
01-0110
         2000
01-0120
         2000
                                                       KIM HEX TO ASCII ROUTINE
                             PRTBYT =$1E3B
         2000
01-0130
                                    =$1E2F
                             CRLF
         2000
01-0140
                             OUTSP
                                    ==$1E9E
01-0150
         2000
         2000
01-0160
                                    =$2500
                             STBUF
01-0170
         2000
                             MAINLINE ROUTINE
01-0180
         2000
                                    *=$2000
01-0190
         2000
01-0200
         2000
                             *******OUTPUT TO THE SOUND CHIF*****
         2000
01-0210
                             FIN ORDER TO SET A SOUND CHIP REGISTER TO
         2000
01 - 0220
                             $A PARTICULAR VALUE, ENTER THIS ROUTINE WITH
          2000
01-0230
                             THE 'X' REGISTER CONTAINING THE SOUND CHIP
         2000
01-0240
                             FREGISTER NUMBER AND THE ACCUMULATOR CONTAINING
01-0250
         2000
                             THE DATA TO BE LOADED INTO THAT REGISTER.
01-0260
         2000
         2000
01-0270
                                                       SAVE DATA
                             OUTPUT TAY
         2000
                A8
01-0280
                                    JSR LATCH
                20 10 20
          2001
01-0290
                                    JSR WRITE
                20 26 20
          2004
01-0300
                                    RTS
01-0310
          2007
                60
01-0320
          2008
                             *******INPUT FROM THE SOUND CHIP*****
01-0330
          2008
                             FIN ORDER TO READ THE CONTENTS OF A
          2008
01-0340
                             PARTICULAR SOUND CHIP REGISTER, ENTER
01-0350
          2008
                             FTHIS ROUTINE WITH THE SOUND CHIP REGISTER
          2008
01-0360
                             NUMBER IN THE 'X' REGISTER. UPON RETURN,
          2008
01-0370
                             THE DESIRED REGISTER DATA WILL BE FOUND
01-0380
          2008
                             IN THE ACCUMULATOR
          2008
01-0390
                             ŷ
01-0400
          2008
                                     JSR LATCH
                             INPUT
          2008
                20 10 20
01-0410
                                     JSR READ
                20 35 20
01-0420
          200B
                                                       PRESTORE DATA
                98
                                     TYA
          200E
01-0430
                                     RTS
          200F
                60
01-0440
01-0450
          2010
                             THE 'LATCH' ROUTINE SIMPLY LATCHES
01-0460
          2010
                             THE SOUND CHIP REGISTER NUMBER INTO
01-0470
          2010
                             THE SOUND CHIP ADDRESS REGISTER FOR
01-0480
          2010
                             #A SUBSEQUENT READ OR WRITE.
01-0490
          2010
01-0500
          2010
                                                       MAKE IT ALL OUTPUTS
                             LATCH
                                     LDA #$FF
                A9 FF
01-0510
          2010
                                     STA DDRA
                8D 13 08
          2012
01-0520
                                     STA DDRB
                8D 12 08
01-0530
          2015
```



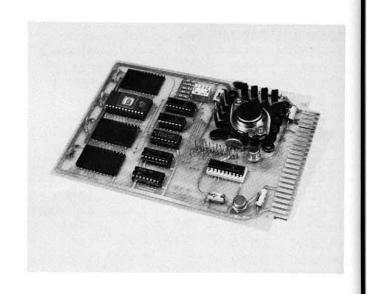
BOX 120 ALLAMUCHY, N.J. 07820 201-362-6574

HUDSON DIGITAL ELECTRONICS INC.

# **ANNOUNCING THREE NEW PRODUCTS**

# 1. 4/8K EPROM CARD

A 4/8K EPROM card, featuring on-board jumper selection of 2708 or 2716 EPROMS. Compact, industry standard 4½ x 6½" card size with on board regulation of all required voltages. Uses the KIM-4 standard 44-pin bus. (EPROMS not included) HDE DM 816-P8 — \$165.00



DM 816-P8 — (EPROMS not included)

# 2. HDE DISK BASIC (Now it's KIM's turn)

HDE Disk Basic has been designed so that the 6502 Basic versions for SYM, KIM, TIM and AIM are subsets, thereby allowing program transfers without any modification in most instances. For program development we've included and enhanced the editing features available in our text editor, TED. Other facilities include: ON ERROR GOTO ...; IF ... THEN ... ELSE; LINE INPUT; PRINT USING; AUTO line numbering; renumbering; hex value input and much more. Disk capabilities include: SAVE, LOAD, RUN, LINK, CHAIN and sequential and random input/output. KIM version available now for HDE Disk based systems — \$175.00

# 3. HDE 'AID' - An Advanced Interactive Disassembler

The Advanced Interactive Disassembler, designed by PCS, Progressive Computer Software, is a resident, two pass disassembler that creates TED compatible source files, with labels assigned to all address references. Addresses external to the object file limits are defined as equates in the source.

# AID Builds Source Files for All Your Object Programs

The creation of source files of any object program is limited only by the size of the object program, the symbol table and the user defined source file buffer. AID will save interim source files to disk. KIM, TIM, SYM and AIM HDE Disk Based versions – \$95.00

# **HDE DISK USER LIBRARY**

The HDE Disk User Library has been established for the exchange of user developed programs and routines. All programs in the library are 'public domain' and available to any HDE Disk System user for a nominal copying charge or on a one-for-one free exchange basis. A list of programs currently available and other information may be obtained from Progressive Computer Software, 405 Corbin Road, York, PA 17403. Enclose a self addressed, stamped envelope for a prompt reply.

# OTHER HDE PRODUCTS INCLUDE:

- 5" and 8" single and dual drive disk systems
- 19" RETMA standard card cage
- 8K static RAM memory
- Prototyping card

- HDE Assembler
- Text Output Processing System
- Comprehensive Memory Test
- Dynamic Debugging Tool (disk and cassette versions)

# COMING SOON:



A KIM based, dual mini drive system for:

- · Program development
- Engineering support
- Word processing applications

Disk FORTH

Dual Channel RS-232C Communications Interface Card

# **HDE Products Are Available From:**

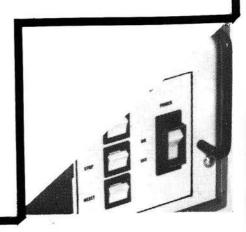
Johnson Computers Box 523 Medina, Ohio 44256 (216) 725-4560

Falk-Baker Associates 382 Franklin Avenue Nutley, NJ 07110 (201) 661-2430

Lux Associates 20 Sunland Drive Chico, CA 95926 (916) 343-5033 Specializing in SYM Progressive Computer Software 405 Corbin Road York, PA 17403 (717) 845-4954

Perry Peripherals P.O. Box 924 Miller Place, NY 11764 (516) 744-6462 Specializing in KIMSI and overseas sales

> A-B Computers 115-B E. Stump Road Montgomeryville, PA 18936 (215) 699-5826



```
01-0540
           2018
                 8E 1F 08
                                      STX OREGA
 01-0550
           201B
                 A9
                    03
                                      LDA #3
                                                          STROBE IN THE REG ADDRESS
 01-0560
           201D
                 8D 10
                        08
                                       STA ORB
 01-0570
           2020
                 A9 00
                                      LDA #0
 01-0580
           2022
                  8D 10 08
                                       STA ORB
 01-0590
           2025
                 60
                                      RTS
 01-0600
           2026
 01-0610
           2026
                               FITHE 'WRITE' ROUTINE ASSUMES THE
 01-0620
           2026
                               PROPER REGISTER VALUE HAS ALREADY
 01-0630
           2026
                               SETUP IN THE SOUND CHIP AND LOADS
 01-0640
           2026
                               THE PROPER SOUND CHIP REGISTER WITH
 01-0650
           2026
                               FITHE CONTENTS OF THE ACCUMULATOR.
 01-0655
           2026
 01-0660
           2026
                 98
                               WRITE
                                      TYA
 01-0670
           2027
                 8D 1F 08
                                      STA OREGA
01-0680
           202A
                 A9 02
                                      LDA #2
01-0690
           2020
                 8D 10
                        08
                                      STA ORB
01-0700
           202F
                 A9 00
                                      LDA #0
01-0710
          2031
                 8D 10 08
                                      STA ORB
01-0720
           2034
                 60
                                      RTS
01-0730
          2035
01-0731
          2035
                               FITHE 'READ' ROUTINE ASSUMES THE PROPER
01-0732
          2035
                               $SOUND REGISTER CHIP HAS BEEN SELECTED
01-0733
          2035
                               JAND READS THAT REGISTER INTO THE
01-0734
          2035
                              JACCUMULATOR.
01-0735
          2035
01-0740
          2035
                 A9 00
                              READ
                                      LDA #0
01-0750
          2037
                 8D 13 08
                                      STA DDRA
01-0760
          203A
                 A9
                    01
                                      LDA #1
01-0770
          2030
                 80
                    10 08
                                      STA ORB
01-0780
          203F
                 AD
                    1F
                        08
                                      LDA OREGA
                                                         GET DATA
01-0790
          2042
                 A8
                                      TAY
01-0800
          2043
                 A9
                    00
                                      LDA #0
01-0810
          2045
                                      STA ORB
                 81)
                    10 08
01-0820
          2048
                 60
                                      RTS
01-0830
          2049
01-0831
          2049
                              FINE 'CLEAR' ROUTINE ZEROS ALL THE REGISTERS
01 - 0832
          2049
                              FIN THE SOUND CHIP.
01-0835
          2049
01-0840
          2049
                 20 73 20
                              CLEAR
                                      JSR INITS
01-0850
          204C
                 A2 00
                                      LDX #0
01-0860
          204E
                 A9 00
                              DOIT
                                      LDA #0
                 20 00 20
01-0870
          2050
                                      JSR OUTPUT
01-0880
          2053
                 E8
                                      INX
01-0890
          2054
                 EO 11
                                      CFX #17
01-0900
          2056
                 DO F6
                                      BNE DOIT
01-0910
          2058
                 00
                                      BRK
01-0920
          2059
01-0925
          2059
                              FTHE 'CHECK' DUMPS THE CONTENTS OF
01-0926
          2059
                              FALL THE SOUND CHIP REGISTERS TO
01-0927
          2059
                              THE SERIAL TERMINAL.
01-0928
          2059
01-0930
          2059
                20 73 20
                              CHECK
                                      JSR INITS
01-0940
          205C
                20 2F
                      1 E
                                     JSR CRLF
01-0950
          205F
                A2 00
                                     LDX #0
01-0960
          2061
                20 08 20
                              GETIT
                                     JSR INPUT
01-0970
          2064
                20 3B 1E
                                     JSR PRTBYT
01-0980
          2067
                20 9E 1E
                                     JSR
                                         OUTSP
01-0990
          206A
                E8
                                     INX
```

01-1000	206B	E0 11	CPX #17 BNE GETIT
01-1010 01-1020	206D 206F	DO F2 20 2F 1E	JSR CRLF
01-1030	2072	00	BRK
01-1040	2073	0.0	-MCT 51 5
01-1060	2073		
01-1061	2073		FTHE 'INITS' ROUTINE SETS UP THE
01-1062	2073		\$6522 WITH PBO-PB7 AS OUTPUTS
01-1063	2073		JAND WRITES A \$00 TO THAT PORT.
01-1064	2073		ŷ
01-1070	2073	A9 FF	INITS LDA #\$FF
01-1080	2075	8D 12 08	STA DDRB
01-1090	2078	A9 00	LDA #O
01-1100	207A	8D 10 08	STA ORB
01-1110	207D	60	RTS
01-1120	207E		
01-1130	207E		
01-1140	207E		A PER A PER A AND AND AND AND AND AND AND AND AND A
01-1150	207E		PEXPLOSION SOUND EFFECT
01-1160	207E	A0 00	EXFLOS LDA #\$0
01-1170	207E	A9 00	
01-1180	2080	A2 06	LDX #6 - \$SETUP REG 6 JSR OUTPUT
01-1190	2082 2085	20 00 20 A9 07	LDA #\$7
01-1200	2083	A2 07	LDX #7 #SAME FOR REG 7
01-1210 01-1220	2087	20 00 20	JSR OUTPUT
01-1220	208C	A9 10	LDA #\$10
01-1240	208E	A2 08	LDX #8
01-1250	2090	20 00 20	JSR OUTPUT
01-1260	2093	A9 38	LDA #\$38
01-1270	2095	A2 OC	LDX #12
01-1280	2097	20 00 20	JSR OUTPUT
01-1290	209A	A9 10	LDA #\$10
01-1300	209C	A2 09	LDX #9
01-1310	209E	20 00 20	JSR OUTPUT
01-1320	20A1	A9 10	LDA #\$10
01-1330	20A3	A2 0A	LDX #10
01-1340	20A5	20 00 20	JSR OUTPUT
01-1350	20A8	A9 00	LDA #O
01-1360	20AA	A2 OD	LDX #13
01-1370	20AC	20 00 20	JSR DUTPUT BRK
01-1380	20AF	00	BKK
01-1390	2080		
01-1400 01-1410	20B0 20B0		THIS SECTION LOADS THE SOUND CHIP
01-1420	20B0		WITH THE FIRST 16 BYTES STARTING AT
01-1430	2080		FLOCATION \$2500
01-1440	2080		7 Ma W W 11 1 M 10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
01-1442	20B0		
01-1450	20B0	A2 00	LOAD LDX #0
01-1460	20B2	BD 00 25	LOOP1 LDA STBUF,X \$NOW GET DATA
01-1470	20B5	20 00 20	JSR OUTPUT
01-1480	2088	E8	INX
01-1490	20B9	EO 11	CPX #17 #DONE YET?
01-1500	20BB	DO F5	BNE LOOP1
01-1510	20BD	40 59 20	JMP CHECK \$DUMP THE CONTENTS
01-1520	2000		OF THE CHIP
01-1530	2000		• END

### More In Store

Now that we have sound output, it's only logical that we should have some sort of analog input. Besides, if we only hook one sound chip to the 6522 we have plenty of lines left--so let's use 'em. I happen to have a NATIONAL ADC0816 laying around that's just waiting to do something.

It's an 8 bit A/D converter with 16 analog inputs. The conversion time is around 100 us and it runs on a single 5 volt supply. Ideal for joysticks and other analog devices.

Look for it in an upcoming column.

### You Got Time?

What about the date? If your micro has need for the time and date, you'll be glad to hear that a new 18 pin, CMOS clock/calendar chip (MSM 5832) has been introduced by OKI Semiconductor (1333 Lawrence Expressway, Santa Clara, CA 95051 (408-984-4842)) that can be easily interfaced to a 6522 VIA. In fact, it was made to interface with micros.

The MSM 5832 chip and necessary crystal (32.768 KHZ) cost under \$15 and is now generally available. If you can't find it locally, I got mine at Concord Computer Components (1973 So. State College, Anaheim, CA 92806 (714) 937-0637).

### More On Communications

If you're interested in computer communications, two magazines recently had articles which will feed your enthusiasm.

Byte magazine (June 1980) had two useful articles which you will want to read.

The first article (on page 24) showed how to build a complete modem with pre-aligned filter modules which eliminates the need for complicated adjustments. The 6860 modem chip was used which is a perfect match for the new 6551 ACIA chip which is being manufactured by Rockwell and Synertek.

Page 140 (of the same issue) presents two methods of having KIM dial your phone. The first method uses the conventional relay approach while the second one uses a D/A converter (just like the one on the Micro Technology Unlimited D/A board) to generate and mix the two signals necessary to create the touch-tone pair.

Doctor Dobbs Journal (June/July 1980) devoted part of an issue to the subject of networking which included an update on the PCNET efforts of Dave Caulkins, several articles on networking and a description of MCALL-C, another communications protocol.

They also had a directory of phone numbers for 144 computerized bulletin board systems.

Lots of things are happening in this area of personal computing and commercial computing, as well. If you're looking for a possible future career in some area of computing, telecommunications is a good choice.

### **HDE Software Bank**

Hudson Digital Electronics (Box 120, Allamuchy, N.J. 07820 (201) 362-6574) has just concluded negotiations which would put Progressive Computer Software Inc. (405 Carbin Rd., York, PA 17403) in charge of maintaining the HDE Users Library.

The plan is to offer utility and applications programs available at a nominal disk copying charge.

Contact HDE and/or Progressive for more details.

# 6502 High-Level Languages Available

Several high level languages are available from the good folks at 6502 Program Exchange (2920 Moana, Reno, NV 89509). For AIM, KIM and SYM systems, they're offering FOCAL, TINY BASIC and XPLO (a compiler) as well as an editor and assembler.

These people have been around since the beginning and done much to help the 6502 attain its present popularity level.

Send \$1 for their latest catalog.

# **MORE**<sup>™</sup> EPROM PROGRAMMER

- 3K RAM EXPANSION SPACE
- OUTPUT PORT EXPANSION
- EPROM SOCKET FOR OFTEN NEEDED SOFTWARE
- READY TO USE ON BARE

# KIM, SYM, AIM

BOARD, SOFTWARE ON KIM FORMAT TAPE, MANUAL, LISTINGS, ALL PERSONALITY KEYS FOR 2708, 2716 (±5 +12V) AND 2716, 2758, TMS 2516 (5V ONLY) -- \$169.95

 2708 EPROM WITH SOFT-WARE IS \$20.00

T.T.I. P.O. Box 2328 Cookeville, TN 38501 Phone: 615-526-7579

# PET, AIM, SYM, KIM OWNERS

- \*Tired of waiting for your cassette?
- \*Want versatile, inexpensive expansion?
- \*Want IBM floppy disk compatibility?



# THE IBM COMPATIBLE FLOPPY DISK SYSTEM WITH 51/4" or 8" DRIVES

- \*Want professional, sophisticated file handling?
- \*Want consistant, reliable operation?
- \*Want simple, easy-to-use disk syntax?

CRS/PDOS

# A NEW SOPHISTICATED DISK OPERATING SYSTEM

\*Want a compatible disk-based Editor/Assembler?

CRS/ASM

# NEW PET OWNERS PEDISK IS AVAILABLE FOR NEW PETS TOO!

# AIM, SYM, KIM OWNERS PEDISK ADAPTOR IS NOW AVAILABLE!

PEDISK PACKAGE 1
5" DISK SYSTEM, CASE AND POWER SUPPLY
PEDISK PACKAGE 2\$895.00
5" DISK SYSTEM, S100 CARD CAGE, CASE AND POWER SUPPLY
PEDISK PACKAGE 2A\$495.00
ADDITIONAL 5" DISK DRIVE, CASE AND POWER SUPPLY
PEDISK PACKAGE 4
8" DISK SYSTEM, S100 CARD CAGE, CASE AND POWER-SUPPLY

EXS100 DISK CONTROLLER BOARD\$49.95	3
BARE BOARD	
EXS100 DISK CONTROLLER KIT \$225.00	)
AIM, SYM, KIM ADAPTOR KIT\$25.00	)
CRS/PDOS SOFTWARE SYSTEM\$75.00	
SPECIFY OLD OR NEW ROMS, MEMORY SIZE 8K, 16K, 32K	
CRS/ASM EDITOR/ASSEMBLER \$150.00	)
SOFTWARE AVAILABLE ONLY FOR EXS100, PEDISK OWNERS	

# \*NEED MORE ROM ROOM?

Toolkit and Word Pro II occupy the same rom space in your PET! No problem for Spacemaker. Simply install both in the Spacemaker and switch back and forth. Add User I/O and you can switch under soft-

SPACEMAKER\$29.00	
USER I/O\$12.95	
CABLE ASSEMBLY AND SOFTWARE ON COMMODORE OR	
PEDISK DISK	
ROM DRIVER	
PORT CONTROL BOARD WITH SOFTWARE LISTING	
ROM I/O	
ROM DRIVER SOFTWARE ON COMMODORE OR PEDISK DISK.	
SEE YOUR LOCAL DEALER OR CONTACT:	

# The Spacemaker

ware control from the user port. User port occupiedthen get Romdriver, a built-in switch control port. Spacemaker can grow as your switching problems do. Don't get caught behind in the ROM RACE.

> MICROTECH P.O. Box 102 Langhorne, PA 19047 215-757-0284

PEDISK, Spacemaker is a trademark of CGRS Microtech Pet, Kim is a trademark of Commodore Aim is a trademark of Rockwell SYM is a trademark of Synertek Toolkit is a trademark of Palo Alto KS. An Evaluation: Marvin L. De Jong

# The FIRST MATE/SECOND MATE By Micromate

Ever since I began doing experimental work with 6502 single-board microcomputers, such as the KIM-1, SYM-1, and the AIM 65, I have looked for a neat and convenient way for my students and me to breadboard circuits to be interfaced to the microcomputer. The FIRST MATE/SECOND MATE combination by MicroMate, P.O. Box 50111, Indianapolis, IN 46256 will probably end my search. In my opinion, this system is an excellent way to prototype and interface circuits to the microcomputer. It will be of great interest to engineers, technicians and experiters as well to those of us involved in technical education.

The SECOND MATE is simply a 2½" by 3½" printed circuit board with a 22/44 pin edge connector on one side, and a set of 44 printed circuit pads that duplicate the application and expansion edges on the KIM-1, SYM-1 or AIM 65. Thus, the SECOND MATE is transparent to any other devices you may want to connect to your microcomputer. Finally, the SECOND MATE has a 40 pin connector that connects to a 40 pin DIP jumper that connects the SECOND MATE to the FIRST MATE by a 40-strand ribbon cable. The DIP jumper is about 6" long. Thus, the SECOND MATE is connected to the microcomputer with the usual 22/44 pin edge connector, and the FIRST MATE connects to 40 of the 44 lines that are available at these connectors.

The FIRST MATE is a 71/2" square printed circuit board upon which is mounted an SK-10 breadboard, three 40-pin connectors, a position for a second SK-10 or another protoboard, four "universal" connectors for GND, +5V, +V and a -V supply. An LED indicates when power is applied, and several filter capacitors are also provided. The three 40-pin connectors on the FIRST MATE connect to either the expansion connector, the application connector or, if you have a SYM-1, the socalled AA connector. Suppose you wish to interface a circuit to the expansion connector on your microcomputer. The 40-pin DIP jumper is then connected to the 40-pin expansion connector on the FIRST MATE, while the SECOND MATE is plugged into the expansion port on the microcomputer.

The eight data lines, the sixteen address lines, and eight control lines are then connected to labelled locations on the SK-10. Each labelled location allows up to five wires to be connected. The control lines are the usual ones, R/W, 02, RES, NMI, IRQ, RDY, SYNC, and one device select line. (For the SYM-1, the device select is the 18 line. Some minor trace cutting and jumpering gives the CS8 line or another device select for the AIM 65.)

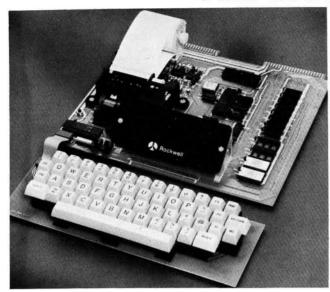
If the FIRST MATE/SECOND MATE are connected to the application port, then the eight pins of Port A and the seven pins of Port B may be accessed on the SK-10 at labelled positions. Note that both the SYM-1 and the KIM-1 do not allow a connection to PB6 at the applications port. If you want to use the FIRST MATE with an AIM 65 you will probably want to jumper PB6 to the SK-10 as well as the control lines CA1, CA2, CB1, and CB2 from the VIA. This would be quite simple, but it would eliminate (or duplicate) some pin functions for the AA connector on the SYM-1. Connections can also be made to the expansion port and the applications port simultaneously if two SECOND MATES and two ribbon cables are purchased.

The geometry of the First MATE was designed to mount on a SYM-1 with nylon spacers and screws. The FIRST MATE can probably be placed on a KIM-1 with no problems. For my AIM 65 I chose to build a little table consisting of two 4" X 8" pine legs and a 14" X 8" masonite perforated board for a top. This not only makes a dust cover for the AIM 65, but it also keeps me from yelling at the cat when he decides to sleep on my microcomputer. If the little table is made about 8" deep then the printer paper can be easily seen. The FIRST MATE can be bolted to the perf-board top. I think it made a neat system, allowing me to work directly over the microcomputer when I was breadboarding a circuit.

Clearly the FIRST MATE was designed for the SYM-1, but with a few simple modifications, some of which are suggested in the literature supplied with the FIRST MATE, it can be used with the AIM 65. No modifications are necessary for operation with the KIM-1. To put the FIRST MATE to the test, I breadboarded the simple stepper motor interface described in this issue. No modifications to the FIRST MATE were required for this circuit.

Although there are other breadboarding schemes available (see TERC, 575 Technology Sq., Cambridge, MA 02139 for other possibilities) that are not being evaluated here because I have little or no experience with them, I can wholeheartedly recommend that you examine the MicroMate system for \$87.50. I think it is an excellent approach to circuit development. I would like to see an AIM 65 version of the system for sale, but the modifications are quite simple.

# AIM 65 BY ROCKWELL INTERNATIONAL



AIM 65 is fully assembled, tested and warranted. With the addition of a low cost, readily available power supply, it's ready to start working for you.

AIM 65 features on-board thermal printer and alphanumeric display, and a terminal-style keyboard. It has an addressing capability up to 65K bytes, and comes with a user-dedicated 1K or 4K RAM. Two installed 4K ROMS hold a powerful Advanced Interface Monitor program, and three spare sockets are included to expand on-board ROM or PROM up to 20K bytes.

An Application Connector provides for attaching a TTY and one or two audio cassette recorders, and gives external access to the user-dedicated general purpose I/O lines.

Also included as standard are a comprehensive AIM 65 User's Manual, a handy pocket reference card, an R6500 Hardware Manual, an R6500 Programming Manual and an AIM 65 schematic.

AIM 65 is packaged on two compact modules. The circuit module is 12 inches wide and 10 inches long, the keyboard module is 12 inches wide and 4 inches long. They are connected by a detachable cable.

### THERMAL PRINTER

Most desired feature on low-cost microcomputer systems . . .

- Wide 20-column printout
- Versatile 5 x 7 dot matrix format
- Complete 64-character ASCII alphanumeric format
- · Fast 120 lines per minute
- · Quite thermal operation
- · Proven reliability

### **FULL-SIZE ALPHANUMERIC KEYBOARD**

Provides compatibility with system terminals . . .

- Standard 54 key, terminal-style layout
- 26 alphabetic characters
- 10 numeric characters
- 22 special characters
- 9 control functions
- 3 user-defined functions

### TRUE ALPHANUMERIC DISPLAY

Provides legible and lengthy display . . .

- · 20 characters wide
- 16-segment characters
- High contrast monolithic characters
- Complete 64-character ASCII alphanumeric format

# PROVEN R6500 MICROCOMPUTER SYSTEM DEVICES

Reliable, high performance NMOS technology.

- R6502 Central Processing Unit (CPU), operating at 1 MHz. Has 65K address capability, 13 addressing modes and true index capability. Simple but powerful 56 instructions.
- Read/Write Memory, using R2114 Static RAM devices. Available in 1K byte and 4K byte versions.
- 8K Monitor Program Memory, using R2332 Static ROM devices. Has sockets to accept additional 2332 ROM or 2532 PROM devices, to expand on-board Program memory up to 20K bytes.
- R6532 RAM-Input/Output-Timer (RIOT) combination device. Multipurpose circuit for AIM 65 Monitor functions.
- Two R6522 Versatile Interface Adapter (VIA) devices, which support AIM 65 and user functions. Each VIA has two parallel and one serial 8-bit, bidirectional I/O ports, two 2-bit peripheral handshake control lines and two fully-programmable 16-bit interval timer/event counters.

# **BUILT-IN EXPANSION CAPABILITY**

- 44-Pin Application Connector for peripheral add-ons
- · 44-Pin Expansion Connector has full system bus
- Both connectors are KIM-1 compatible

# TTY AND AUDIO CASSETTE INTERFACES

Standard interface to low-cost peripherals . . .

- · 20 ma. current loop TTY interface
- Interface for two audio cassette recorders
- Two audio cassette formats: ASCII KIM-1 compatible and binary, blocked file assembler compatible

### ROM RESIDENT ADVANCED INTERACTIVE MONITOR

Advanced features found only on larger systems . . .

- Monitor-generated prompts
- Single keystroke commands
- Address independent data entry
- Debug aids
- Error messages
- Option and user interface linkage

# ADVANCED INTERACTIVE MONITOR COMMANDS

- Major Function Entry
- Instruction Entry and Disassembly
- Display/Alter Registers and Memory
- Manipulate Breakpoints,
- Control Instruction/Trace
- Control Peripheral Devices
- Call User-Defined Functions
- Comprehensive Text Editor

### LOW COST PLUG-IN OPTIONS

- A65-010—4K Assembler—symbolic, two-pass A65-020—8K BASIC Interpreter
  - \$79.00
- 99.00 50.00

3K RAM Expansion Kit

# POWER SUPPLY SPECIFICATIONS

- +5 VDC ± 5% regulated @ 2.0 amps (max)
- +24 VDC ±15% unregulated @ 2.5 amps (peak) 0.5 amps average

# PRICE: \$389.00(1K RAM)

Plus \$4.00 UPS (shipped in U.S. must give street address), \$10 parcel post to APO's, FPO's, Alaska, Hawaii. All international customers write for ordering information.

We manufacture a complete line of high quality expansion boards. Use reader service card to be added to our mailing list, or U.S. residents send \$1.00 (International send \$3.00 U.S.) for airmail delivery of our complete catalog.









# 32 K BYTE MEMORY

# RELIABLE AND COST EFFECTIVE RAM FOR 6502 & 6800 BASED MICROCOMPUTERS

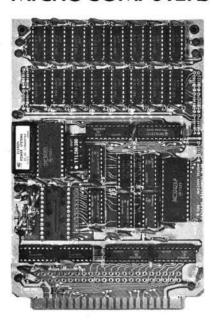
# AIM 65-\*KIM\*SYM PET\*S44-BUS

- \* PLUG COMPATIBLE WITH THE AIM-65/SYM EXPANSION CONNECTOR BY USING A RIGHT ANGLE CONNECTOR (SUPPLIED) MOUNTED ON THE BACK OF THE MEMORY BOARD.
  MEMORY BOARD EDGE CONNECTOR PLUGS INTO THE

- MEMORY BOARD EDGE CONNECTOR PLUGS INTO THE 6800 S 44 BUS.
  CONNECTS TO PET OR KIM USING AN ADAPTOR CABLE. RELIABLE—DYNAMIC RAM WITH ON BOARD INVISIBLE REFRESH—LOOKS LIKE STATIC MEMORY BUT AT LOWER COST AND A FRACTION OF THE POWER REQUIRED FOR STATIC BOARDS.
  USES +50 VONLY, SUPPLIED FROM HOST COMPUTER. FULL DOCUMENTATION. ASSEMBLED AND TESTED BOARDS ARE GUARANTEED FOR ONE YEAR AND PURCHASE PRICE IS FULLY REFUNDABLE IF BOARD IS RETURNED UNDAMAGED WITHIN 14 DAYS.

ASSEMBLED	WITH 32K RAM	\$419.00
&	WITH 16K RAM	\$349.00
TESTED	WITHOUT RAM CHIPS	\$279.00
HARD TO GE	T PARTS (NO RAM CHIPS)	
WITH BOAR	D AND MANUAL	\$109.00
BARE BOAR	D & MANUAL	\$49.00

PET INTERFACE KIT—CONNECTS THE 32K RAM BOARD TO A 4K OR 8K PET. CONTAINS: INTERFACE CABLE, BOARD STANDOFES. POWER SUPPLY MODIFICATION KIT AND COMPLETE INSTRUCTIONS.



### 16K X 1 DYNAMIC RAM

THE MK4116-3 IS A 16,384 BIT HIGH SPEED NMOS, DYNAMIC RAM. THEY ARE EQUIVALENT TO THE MOSTEK, TEXAS INSTRUMENTS, OR MOTOROLA 4116-3.

\* 200 NSEC ACCESS TIME, 375 NSEC CYCLE TIME.

\* 16 PIN TIL COMPATIBLE.

- BURNED IN AND FULLY TESTED.
  PARTS REPLACEMENT GUARANTEED FOR ONE YEAR.
  \$8.50 EACH IN QUANTITIES OF 8

### 6502 & 6800

### 64K BYTE RAM AND CONTROLLER SET

- MAKE 64K BYTE MEMORY FOR YOUR 6800 OR 6502. THIS CHIP SET INCLUDES: \* 32 M5K 4116-3 16KX1, 200 NSEC RAMS. \* 1 MC3480 MEMORY CONTROLLER. \* 1 MC3242A MEMORY ADDRESS MULTIPLEXER AND COUNTER. \* DATA AND APPLICATION SHEETS. PARTS TESTED AND GUARANTEED. \$295.00 PER SET



1230 W.COLLINS AVE. ORANGE, CA 92668 (714) 633-7280

ents please add 6% sales tax. Mastercharge epted. Please allow 14 days for checks to Phone orders welcome. Shipping charges ed to all shipments.

ALL ASSEMBLED BOARDS AND MEM-ORY CHIPS CARRY A FULL ONE YEAR REPLACEMENT WARANTY.

# HERE'S A NEAT COMBINATION

# **IDEAL FOR DEDICATED INDUSTRIAL OR PERSONAL APPLICATION**

# **FEATURES**

- PLUGS DIRECTLY INTO AND COVERS UPPER HALF OF KIM-1. EXPANSION FINGERS CARRIED THROUGH FOR FURTHER EXPANSION.
- I/O-POWERFUL 6522 VIA PROVIDED (VERSATILE INTERFACE ADAPTER) 16 BI-DIRECTIONAL I/O LINES 4 INTERRUPT/HANDSHAKE 2 INTERVAL TIMERS SHIFT REGISTER FOR SERIAL-PARALLEL/PARALLEL-SERIAL OPERATIONS.
- RAM-SOCKETS PROVIDED FOR 4K RAM CONTIGUOUS WITH KIM RAM. (LOW POWER MOSTEK 4118 1KX8's)
- COMPLETE DOCUMENTATION

- **EPROM-SOCKETS PROVIDED FOR** (INTEL 2716 2KX8's)
- BLOCK SELECT SWITCHES FOR EPROM USABLE IN ANY ONE OF FOUR 8K BLOCKS FROM 8000H.
- AUTOMATIC RESET ON POWER-UP AND SWITCH SELECTABLE INTERRUPT VECTORS
- PERMITS UNATTENDED OPERATION.
- LOW POWER CONSUMPTION-5V AT 300 Ma. FULLY LOADED
- **BUFFERED ADDRESS LINES**
- HIGH QUALITY PC BOARD, SOLDER MASK
- ASSEMBLED AND TESTED

## **APPLICATIONS**

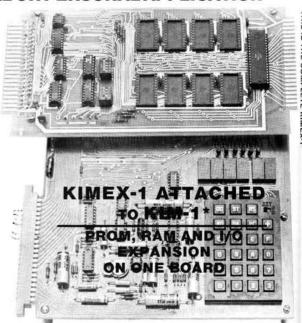
PROM, RAM AND I/O EXPANSION ON ONE BOARD HAVING MANY INDUS-TRIAL/HOME APPLICATIONS FOR DATA ACQUISITION, PROCESS CONTROL, AUTOMATIC CONTROL OF FURNACE, SOLAR HEAT, LIGHTING, APPLI-



PA RESIDENTS INCLUDE 6% STATE SALES TAX

# **DIGITAL ENGINEERING ASSOCIATES**

P.O.BOX 207 • BETHLEHEM, PA 18016



\$139.95 LIMITED TIME 1K RAM FREE!!

KIM IS A REGISTERED TRADEMARK OF MOS TECHNOLOGY, INC.

# Nuts And Volts No. 3 Address Decoding

Gene Zumchak

An important consideration in microprocessor system design is address decoding. Address lines are decoded from the highest order lines to subdivide memory space into smaller blocks. For example, the top three lines, can be used to divide memory into eight 8K blocks; the top four lines, into sixteen 4K blocks; the high six lines, into sixty-four 1K blocks; etc. There are numerous ways to do the decoding in hardware. If addresses need to be changed often, then dip switches and open collector Exclusive NOR (compare) gates can be used to compare any number of address lines with the selected polarity of that address line. The open collector outputs are wire-ORed together. If any gate is false the output will go low. An additional EX-NOR gate can be wired as an inverted to give a low true output. Figure 1. shows this method used to generate the 1K select for \$1000 (000100). If the address decoding is to be permanent, a single 3 to 8 decoder like a 74LS138 can be used to give one, or several 1K, 2K, 4K, or 8K selects. Figure 2. shows a 74LS138 wired to give a select for \$1000. Still another method is to use a 4-bit magnitude comparator chip, like the 74LS85. These can be used with switches on one of the word inputs, and also can be cascaded to compare longer words.

For 6502 systems, some users use  $\emptyset 2$  as an input to address decoders. This transfers the strobe action required for writing from the write input to the chip select. It also means than "reads" will be gated with  $\emptyset 2$ . The user can get away with this only because the hold time requirement for the 6502 on a read operation is so short. As mentioned in the first column, if  $\emptyset 2$  is seriously delayed via the address decode paths, the strobing action could occur after the write data has already gone away. In general, it is not the best practice to "gate" write data with the strobing signal.

For ROM selects, it is desireable to gate in the R/W signal, so that the ROM select can never go true for a write operation. In the AIM, for example, ROM selects are generated from a 2 to 4 decoder. Ironically, this decoder has a gate input that was grounded instead of using the inverted R/W signal. If a write operation is attempted to ROM area, both the ROM and 6502 will attempt to drive the bus. Fortunately, most chips are designed to take momentary shorting and it is most unlikely that any harm will come to the 6502 or ROM. Still, it is careless design not to consider that writes may be attempted to read-only space.

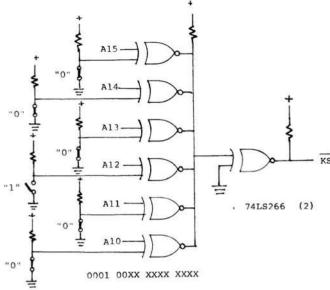


Fig. 1. 1K Select Using EX-NOR

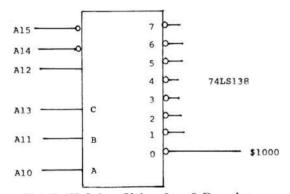


Fig. 2 1K Select Using 3 to 8 Decoder

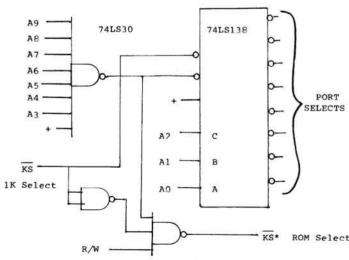


Fig. 3. Stealing Port Selects.

### Stealing Addresses

What does one do when a few addresses are needed for I/O ports? Is it necessary to waste a large chunk of space for a few addresses? Clearly, more address lines can be decoded so that decoding is complete.

Still, it is questionable whether that helps much, since if the remaining space is to be used, it will have to be decoded to exclude those addresses. If you have space set aside for ROM, however, and if you won't need every last word, then it is possible to steal a few addresses for I/O without having to waste any other space. Suppose we have a 1K select at \$1000 which we will use for ROM. The circuit of figure 3. steals the top eight addresses of a 1K select. The ROM will respond only to 1016 addresses. The top eight addresses generate eight I/O selects with a 74LS138.

When designing 6502 controllers from scratch, the address stealing method illustrated can be used to extract I/O addresses from zero page. Rarely is all, or even half, of zero page needed for scratch pad. Putting I/O in zero page not only can considerably cut program length, but also speed up execution time. In some of my early controller designs, I used a pair of 256 x 4 RAM chips, and decoded addresses so that the RAM straddled pages zero and one. The low half of page zero was thus available for I/O.

### Special 6502 Address Considerations

All 6502 systems have two address decoding needs in common. First of all, a select must respond to the very highest addresses where the reset and interrupt vectors are located. (It is too bad that one of the unused pins on the 6502 could not have been used for an open drain vector select. This would have allowed the user to wire-OR this select with his own ROM area for response to the reset and interrupts.) The other consideration, of course, is that all 6502 systems need RAM in zero page and page one (for stack).

Interestingly, the KIM, SYM, and AIM use three different methods for interrupt response. The unexpanded KIM avoids the interrupt vector problem by not decoding the top three address lines so that every 8K block is the same. Thus the unexpanded KIM responds to \$FFFC at \$1FFC. If a KIM is expanded, its address decoder must be enabled only in the lowest 8K block. The interrupt vector area must be decoded with an open collector decoder and wire-ORed to KIM's K7 select (\$1C00-\$1FFF). The SYM causes the response to the reset vector to be ROM at \$8FFC, but the response to the interrupt vectors to be the system RAM at \$A600. How does it perform this magic?

The SYM's reset lines go as usual, to the VIA port chips. All I/O lines on the VIA port chips come up in a high state at rest. The CA2 line of one of the VIAs is inverted to give a low-true Power On Reset signal which is effectively wire-ORed to the monitor ROM. Thus upon power up, the SYM finds the reset addresses at \$8FFC and \$8FFD, not because of decoding, but because the monitor ROM is held fast enabled by the POR line. One of the first things the reset program does is to reset the POR line. This line also inhibits normal address decoding.

After POR is reset, normal address decoding takes place, and response to the interrupt vectors will be to the system RAM area (which is preloaded with default interrupt vectors at reset time).

The AIM's solution is the simplest. It merely puts its 8K monitor in the highest 8K block of memory. Thus the reset and vector select is the normal ROM select.

The KIM, SYM, and AIM can all be used as the basis for dedicated controllers. In such an application, it is usually desireable for Reset to cause the user's controller program to begin. For either the KIM or SYM this is no problem. The KIM will require external decoding of the reset vector space. The decode can be wire-ORed to the controller's ROM. The SYM allows the POR signal to be alternatively jumpered to any of the on board ROM sockets. The AIM, unfortunately, will require that some cutting be done to the board, and further decoding tacked on, so that monitor programs can still be used, without the monitor responding to the topmost vector addresses. For any of the three systems mentioned, when using them in a controller application, some input condition should be defined which will cause the program to enter the board's normal monitor programs.

### Summary

Address decoding uses the highest address lines to subdivide memory space into smaller chunks. Selects are used to enable RAM, ROM and I/O. Address selects can use Ø2 as an input, thus including the strobing action required for writing in the select. ROM selects should include the R/W signal so that they will not respond to write operations. Address stealing can be used to obtain port selects from ROM area without wasting a large chunk of memory space. Similary, I/O addresses may be stolen from zero page RAM area. Various methods can be used to respond to the Reset and interrupt vectors at the top of memory space. A particularly versatile method is the Power On Reset used on the SYM.

I welcome any comments or criticisms you may have of the material in this column. I invite your suggestions for topics for future columns. However, time and space do not allow major design projects for the column.

# EXCERT, INCORPORATED \*\*\* AIM-65 \*\*\*

# **SPECIAL**

A65-4AB	AIM-65 w/4K RAM	
	Assembler & BASIC ROM	\$595

P/N		QTY 1-9	SPARE PARTS (When Available)			
A65-1 A65-4 A65-A	AIM-65 w/1K RAM AIM-65 w/4K RAM Assembler ROM	\$375 \$450 \$85	A65-P A65-D	Printer Complete Display Bd. w/Exchange of Old Bd. Keyboard	\$50 \$85 \$50 \$30	
A65-B	BASIC ROM	\$100	A65-K	Keyboard		

A65-B	BASIC ROM	\$100			100 Al 120 (2011
		ACCESSO	ORIES		
P/NO.		QTY 1-9	P/NC	).	QTY 1-9
Power s (fully A) PRS3 + 1 COI PRS4 + 1 COI From The ENC1 AIM ENC1A ENC4 ENC3A ENC	Supplies IM-65 Compatible) 5V at 3A, +24V at 1A w/m rd, etc. 5V at 2A, +24V at .5A w/m rd, etc.  Enclosure Group I-65 case w/space for PRS3/P I-65 case w/space f	ntg hardware,	MCP2 MEB2 PGR2 PI02 PTC2	Seawell Marketing, Inc.  Little Buffered Mother™-Sing style) mother card takes MEI and PI02. Has on board 5 AIM-65, 4 expansion slots. Ro to duplicates on sides w/4K Rough SEA 16™-16K static RAM w/regulators and address swilter and sockets, up to 8 EPROMS si execute after programming Parallel I/O Bd w/4-6522's Proto/Blank™-Prototype card	le 44 pin (KIM-4 B2, PGR2, PTC2 bV regulator for utes A&E signals AM\$199 bd takes 2114L tches\$325 br 5V EPROMS ttors, 4 textool multanously, can\$299\$260 d that fits MCP2\$49 coders, switches
MCP1 Mo MI slo MEB1 Me 65 EP PTC1 Pro KI VIB1 Vio	e Computerist, Inc. other Plus <sup>tm</sup> - Dual 44 pin mot EB1, VIB1, PTC1, fully buffere ots underneath the AIM emory Plus <sup>tm</sup> - 8K RAM, 8K P 22 I/O chip and prograr PROMS (w/cables \$215) oto Plus <sup>tm</sup> - Prototype card M-1 MEB1, VIB1 deo Plus <sup>tm</sup> - Video bd w/128 ar, up to 4K display RAM, SCII keyboard interfaces w/ca	d, 5 expansion\$80  ROM sockets, nmer for 5V\$200  same size as\$40  char, 128 user light pen and	ADC1	A/D: 8 channels; D/A: 2 channels ±12v to ±15 volts @ 100 ma and from user 6522  Ellaneous Approved Thermal Paper Tap 5/165 rolls 6/2114 RAM Chips  CLOSE-OU From Beta Com 32K Dynamic Memory Card DC converters (5V only .8A r	2 1/0 ports \$115.00 pe \$15 \$45 IT! puter l w/on bd DC to

# **SYSTEMS**

We specialize in assembled and tested systems made from the above items. Normally, the price will be the total of the items, plus \$5 for shipping, insurance and handling. Please call or write for exact prices or if questions arise.

Higher quantities quoted upon request. COD's accepted. Add \$5 for shipping, insurance, and handling. Minnesota residents add 4% sales tax. Mail Check or Money Order To: EXCERT, INC.
Educational Computer Division
P.O. BOX 8600
WHITE BEAR LAKE, MN. 55110
612-426-4114

# A Simple Interface For A Stepper Motor

Marvin L. De Jong Department of Mathematics-Physics The School of the Ozarks

The circuit shown in Figure 1 and the programs given in Listing 1 allow you to drive a stepper motor with your 6502 based microcomputer. Why run a stepper motor? Perhaps to drive a solar panel to follow the sun, homebrew your own x-y plotter, run a pump at a preselected rate, or turn your robot's head. Whatever your application may be, here is some information to get you started working with stepper motors. You will want to get additional information from the following companies:

### AIRPAX

North American Philips Controls Corp. Chesire Industrial Park Cheshire, CONN 06410 (203) 272-0301 Dana Industrial 11901 Burke St. Santa Fe Springs, CA 90670 (213) 698-2595 You can get a nice Stepper Motor Handbook from AIRPAX, and the specification sheet for the Stepper Motor IC Driver SAA1027 also is available from AIRPAX. The circuit we used made use of this integrated circuit driver and an AIRPAX 82701 stepper motor. The circuit was breadboarded on a FIRST MATE/SECOND MATE system from MicroMate.

The circuit of Figure 1 consists of a 7406 inverter with high voltage open-collector outputs. Two pins of the Port B application port on the computer drive the 7406 which in turn controls the trigger (T) input and the rotation direcn (R) input on the stepper motor IC driver. The driver chip controls the stepper motor.

Listing 1 gives several subroutines that may be used to control the motor. The instructions in the INITIALIZE routine should be used near the beginning of any program to drive the stepper motor. These instructions place the proper logic levels on the T and R pins. In Listing 1 the initilization instructions are part of a short program from \$0300 to \$0328 that will run the stepper motor at a constant rate. The rate used in this program is about 200 steps/second, near the maximum rate for this particular motor. Since each step for the 82701 is a 7.5° step, the rotation rate is 250 rpm.

The INITIALIZE and MOTOR RUN routines call two subroutines, TRIGGER and either CW or CCW. Calling subroutine TRIGGER produces one step on the stepper motor. If the TRIGGER call is preceded by a subroutine call for CW, then the motor will turn clockwise (CW). If CCW (for counterclock-

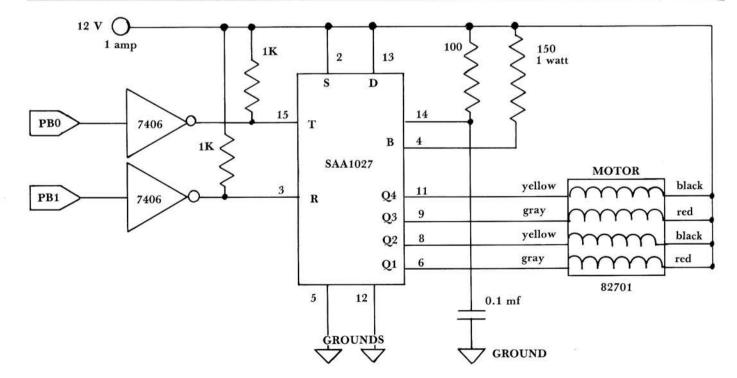


Figure 1. Stepper motor interface. The SAA1027 is a special driver integrated circuit. The 7406 will also require five volts for its own power.

wise) is called, then the motor will turn counterclockwise. The MOTOR RUN routine is an infinite loop, and is listed here to show how to make the motor run. Note that we have used the T1 timer on the 6522 VIA to control the time between steps.

Subroutine MOVE can be used to turn the stepper motor a prescribed number of steps, either CW or CCW depending on which subroutine is called. The number of steps is stored in location STEPS at address \$0000. Again, the T1 timer on the 6522 VIA is used to produce the necessary delay between

steps. The stepper motor is not capable of turning as fast as the computer can toggle the T input, hence either a timer delay or a delay loop must be used to wait.

Be sure to get all the information about various motors and drivers before you get started with your project. Quite obviously, different projects will demand different motors; larger, smaller, geared, linear actuators, etc. Then build something spectacular and let us hear about it.

Listing 1. Driver Routines for the Stepper Motor Interface.

0300 A9 03 0302 8D 02 A0 0305 A9 00 0307 8D 00 A0 030A A9 40 <b>M</b>		STA PBDD LDA \$00 STA PBD LDA \$40	Set up Port B to make pins PB0 and PB1 output pins. Pull driver pins T and R to logic one through the 7406 inverter. Put the T1 timer in its free-running
030C 8D 0B A0		STA ACR	mode by setting bit six to logic one. Set up the T1 timer to time out every
030F A9 86		LDA \$86 STA T1LL	5 milliseconds giving 200 steps/sec.
0311 8D 04 A0 0314 A9 13	MORE	LDA \$13	(\$1386 + 2 = 5000)
0316 8D 05 A0	MORL	STA T1LH	Now the timer is loaded and running.
0319 2C 0D A0	LOAF	BIT IFR	Has the timer timed out?
031C 50 FB		BVC LOAF	No. Then loaf here.
031E 20 07 04		JSR CW	Subroutine CW will result in motor
0321 20 00 04		JSR TRIGGER	running clockwise, CCW turns it counter-
0324 AD 04 A0		LDA T1CL	clockwise. Subroutine TRIGGER produces
0327 18		CLC	one step of the motor.
0328 90 EA		BCC MORE	Clear the interrupt flag, then return
		200 200	to make another step.
0400 EE 00 A0	TRIGGER	INC PBD	Pulse the T input of the stepper motor
0403 CE 00 A0		DEC PBD	driver.
0406 60	Newscare	RTS	The second secon
0407 A9 02	CW	LDA \$02	Bring the R input to logic zero for
0409 0D 00 A0		ORA PBD	clockwise (CW) rotation, by making
040C 8D 00 A0		STA PBD RTS	PB1 logic one.
040F 60	COTIT		D: 1 D: 1 - for
0410 A9 FD	CCW	LDA \$FD	Bring the R input to logic one for counterclockwise (CCW) rotation, by
0412 2D 00 A0 0415 8D 00 A0		AND PBD STA PBD	making PB1 logic zero.
0413 6D 00 A0		RTS	making 1 D1 logic zero.
	MOVE	LDA \$00	Set up T1 for the one-shot mode
0500 A9 00 0502 8D 0B A0	MOVE	STA ACR	by clearing the 6522 ACR.
0505 20 10 04		JSR CCW	Motor will turn counterclockwise.
0508 A9 87		LDA \$87	Timer will wait 5 milliseconds between
050A 8D 04 A0		STA T1LL	steps.
050D A9 13	AGAIN	LDA \$13	
050F 8D 05 A0		STA T1LH	Timer is now loaded and running.
0512 2C 0D A0	WAIT	BIT IFR	Has it timed out?
0515 50 FB		BVC WAIT	No. Then wait here.
0517 20 00 04		JSR TRIGGER	Here the motor turns one step.
051A C6 00		DEC STEPS BNE AGAIN	Decrement the step counter. Has it reached zero?
051C D0 EF		RTS	Yes. Then turn is complete.
051E 60		RIO.	1 co. Then turn to complete.

r	93.22.WW	200	2412		2013/197	4.52		120		7
ı	6502	7.45	10 @	6.95	50 @	6.55	100	(0)	6.15	
ı	6502A	8.40	10 @	7.95	50 @	7.35	100	@	6.90	
ı	6520 PIA	5.1	5 10	@ 4.9	0 50 @	4.45	100	@	4.15	
l	6522 VIA	7.1	5 10	@ 6.9	5 50 @	6.45	100	@	6.00	
l	6532	7.90 1	0 @	7.40	50 @	7.00	100	@	6.60	
l	2114-L45	50		4.75	20 @	4.45	100	@	4.15	
l	2114-L30	00		5.95	20 @	5.45	100	@	5.10	
l	2716 EPF	ROM		21.00	5@	19.00	10	@	17.00	
ı	4116-200	ns RA	MA		7.00		8	@	6.25	
ı	6550 RAI	M (PET	8K)						12.70	
l	21L02	20							.90	
ı	S-100 W	ire Wra	p			2.85	10	@	2.65	
l	S-100 So	lder Ta	il			2.35	10	@	2.15	
ı										

### CASSETTES-AGFA PE-611 PREMIUM

High output, low noise, 5 screw housing, labels.
C-10 10/5.65 50/25.00 100/48.00
C-20 10/6.45 50/29.50 100/57.00
C-30 10/7.30 50/34.00 100/66.00
All other lengths available. Write for price list.

# DISKS

115 E. Stump Road

Montgomeryville, PA 18936

(write for quantity prices)



SCOTCH 8" Disks		10/\$31.00
SCOTCH 5.25" Disks		10/ 31.50
Verbatim 5.25" Disks		10/ 24.50
Diskette Storage Pages		10/ 3.95
Disk Library Cases	8'' - 2.95	5" - 2.15
BASF 5.25" Disks		10/ 25.00
BASF 8" Disks		10/ 27.00

# ATARI-INTRODUCTORY SPECIAL

Atari 400, Atari 800, all Atari Modules 20% OFF

215-699-5826

# Commodore CBM-PET SPECIALS

-Up to \$235 free merchandise with purchase of one of following CBM-PET items:

items:	FI	REE
8032 32K-80 column CRT	\$1795	235
8016 16K-80 column CRT	1495	205
8050 Dual Disk Drive-950,000 bytes	1695	220
CBM Modem-IEEE Interface	395	50
CBM Voice Synthesizer	395	50
8N full size graphics keyboard	795	100
16N full size graphics keyboard	995	135
32N full size graphics keyboard	1295	170
16B full size business keyboard	995	135
32B full size business keyboard	1295	170
2040 Dual Disk Drive-343,000 bytes	1295	170
2022 Tractor Feed Printer	795	100
2023 Pressure Feed Printer	695	90
C2N External Cassette Deck	95	12
Used 8K PETs (limited quantities)	495	

# \*\*\*\* EDUCATIONAL DISCOUNTS \*\*\*\*

Buy 2 computers, get 1 FR	==
CBM Full Size Graphics Keyboard	\$ 74
CBM Word Pro I-for 8K PET	25
CBM WordPro II-16 or 32K, 2040, Printer	88
CBM WordPro III-32K, 2040, Printer	178
VISICALC for PET (CBM/Personal Software)	\$128
CBM Assembler/Editor (disk)	89
CBM General Ledger, A/P, A/R NEW!	270
Programmers Toolkit-PET ROM Utilities	\$ 44.90
PET Spacemaker Switch	22.90
Dust Cover for PET	7.90
IEEE-Parallel Printer Interface for PET	79.00
IEEE-RS232 Printer Interface for PET	149.00

A B Computers



Centronics 737 Proportional Spacing Printer	\$845	
NEC Spinwriter-parallel	2450	
SYM-1 \$209 with 4K RAM	\$ 238	
SYM BAS-1 BASIC in ROM	85	
SYM RAE-1/2 Assembler in ROM	85	
MDT 1000 Synertek Development System	1345	
KTM-2/80 Synertek Video Board	349	
KIM-1 (add \$34 for power supply)	159	
Seawell Motherboard-4K RAM	195	
Seawell 16K Static RAM-KIM, SYM, AIM	320	
S-100 Static RAM kit SALE	198	
Leedex Video 100 12" Monitor	129	
Zenith Z19 Terminal (factory asm.)	770	
KL-4M Four Voice Music Board for PET	\$34.90	
Visible Music Monitor (4 Voice) for PET	29.90	
SPECIAL—KL-4M with Visible Music Monitor	59.90	
	\$9.95	
Machine language version—you can't win at L	.evel 5.	
PAPER MATE 60 Command PET Word Processor Full-featured version by Michael Riley	\$29.95	

# P

### A P Products 15% OFF

All Book and Software Prices are Discounted PET Personal Computer Guide (Osborne) \$12.75 PET and the IEEE-488 Bus (Osborne) 12.75 6502 Assembly Language (Osborne) 9.45 Programming the 6502 (Zaks) 10.45 6502 Applications Book (Zaks) 10.45 Programming a Microcomputer 6502 7.75 6502 Software Bookbook (Scelbi) 9.45

WRITE FOR CATALOG

Add \$1 per order for shipping. We pay balance of UPS surface charges on all prepaid orders.

# DISK DRIVE WOES? PRINTER INTERACTION? MEMORY LOSS? ERRATIC OPERATION? DON'T BLAME THE SOFTWARE!





Power Line Spikes, Surges & Hash could be the culprit! Floppies, printers, memory & processor often interact! Our unique ISOLATORS eliminate equipment interaction AND curb damaging Power Line Spikes, Surges and Hash. \*ISOLATOR (ISO-1A) 3 filter isolated 3-prong sockets; integral Surge/Spike Suppression; 1875 W Maximum load, 1 KW load any socket . . . . . . . . . . . . . . . . . \$56.95 \*ISOLATOR (ISO-2) 2 filter isolated 3-prong socket banks; (6 sockets total); integral Spike/Surge Suppression; 1875 W Max load, 1 KW either bank . . . . . . \$56.95 \*SUPER ISOLATOR (ISO-3), similar to ISO-1A except double filtering & Suppression . . . . \$85.95 \*ISOLATOR (ISO-4), similar to ISO-1A except unit has 6 individually filtered sockets . . . . \$96.95 \*ISOLATOR (ISO-5), similar to ISO-2 except unit has 3 socket banks, 9 sockets total . . \$79.95 \*CIRCUIT BREAKER, any model (add-CB) Add \$ 7.00 \*CKT BRKR/SWITCH/PILOT any model ..... Add \$14.00 (-CBS)

PHONE ORDERS 1-617-655-1532

Electronic Specialists, Inc.

171 South Main Street, Natick, Mass. 01760

Dept. C

VISA

# END FRUSTRATION!!

FROM CASSETTE FAILURES
PERRY PERIPHERALS HAS
THE HDE SOLUTION
OMNIDISK SYSTEMS (5" and 8")

**ACCLAIMED HDE SOFTWARE** 

- Assembler, Dynamic Debugging Tool, Text Output Processor, Comprehensive Memory Test
- Coming Soon—HDE BASIC PERRY PERIPHERALS S-100 PACKAGE

Adds Omnidisk (5") to Your KIM/S-100 System

- Construction Manual—No Parts
- FODS & TED Diskette
- \$20. +\$2. postage & handling. (NY residents add 7% tax) (specify for 1 or 2 drive system)

Place your order with: PERRY PERIPHERALS P.O. Box 924 Miller Place, N.Y. 11764 (516) 744-6462

Your Full-Line HDE Distributor/Exporter

# **GET rich QUICK**

Gene Zumchak

Actually, it was never my intention to get rich. It's just that I've dropped out of the working world for several months to concentrate on writing a book, and I was starting to miss having a little income. Last summer I read Don Lancaster's "Incredible Secret Money Machine" which is a very entertaining dissertation on going into business for yourself. A couple of his ideas are keep it small, and sell it cheap. It occurred to me that selling some blank PC boards might fit those qualifications. So I asked myself, what does everyone need? My most useful accessory is my EPROM programmer. I don't need it that often, but it's indispensible when I do. With 2708's dropping down to the \$7 level, and five volt only 2716's dipping below \$20, it would seem that no one should be without an EPROM programmer.

In small quantities I have to pay a little over \$6 for a blank board. I figured if I offered the board for \$19, I'd make \$10 on every one I sold. If I sold a modest fifteen a month, that would make a \$150 dent in my office overhead of almost \$400. I certainly wouldn't get rich, but it would help a little. It

seemed simple enough.

I should have known better. You just can't drop a blank PC board into an envelope and mail it. You need a parts list, schematic, software, circuit description, software description, etc. I already had much of that material, but it required updating, and I ended up doing most of it over from scratch. Before I was finished, I had over 20 pages of documentation, and about \$1500 of my time invested. I'll need to sell 150 boards just to pay for my lost time. That is, that's how many I'd have to sell IF I made the \$10 a board that I had planned on.

After my ad came out, the inquiries came "pouring" in. Unfortunately, the material I send out is over an ounce and it's costing me \$.28 to mail it first class. Then there's the cost of the printed material. In all, it costs over \$.50 for every inquiry. If one in twenty (a very high return), results in an order, then it will cost me \$10 in mailings to get that order. Well, there goes that \$10 profit. Of course, I failed to account for the \$10 of my time I spend processing the info requests. Then there's the cost of placing the ad. With a little bit of luck, I'll only lose

two or three dollars on every board I sell. Make that five. I forgot to account for some of my overhead. Boy am I dumb.

It sort of looks like, the fewer boards I sell, the better off I am. I guess I should consider myself very fortunate that I've sold only three boards. It does make me wonder, though, how all you non-customers out there program your EPROMs. Maybe you all bought programmers last year. I guess others are waiting for the price to drop.

The very saddest part of this situation is that like other forms of gambling, you don't know how to stop. I reason, I already have \$1500 sunk into this, I might as well stick it out a little longer. There's real-

ly no hope for me.

Actually, I have been selling KIM accessories for years, so I really ought to know better. For my several thousand hours already invested, I'm only a thousand dollars in the hole. At least I can take comfort in knowing that my lack of success is not attributable to poor quality or design. My customers (both of them) are just thrilled with my work.

If nothing else, I've developed a great deal of respect for those others who are building and selling hardware, and actually making a living at it. If you have designed and built something for yourself that you think the rest of the world could use, forget it quickly, before it's too late. Take a cold shower. If you're thinking of saving a little money by designing and building something yourself, save yourself the misry. Someone else has already done it. Just to duplicate my hardware and software efforts on a simple project like the Programmer would take at least \$500 of your time. You're farther ahead using your spare time to sell hamburgers at minimum wage and buying yourself a really nice programmer. But then there's not that satisfaction of doing it yourself.

Actually, the programmer project was the good news. I haven't even told you about the other board, the EPROM Emulator. But that will have to wait. I have to go. There's a couple of gentlemen in white coats at my door. I don't believe it. At last, some customers.

# **KIM-1 TIDBITS**

Harvey B. Herman Chemistry Department University of North Carolina at Greensboro Greensboro, NC 27412

This article is the second in what I hope is a continuing series on the KIM. My intention is to share with others programs which should make KIM easier to use. The reader will please note that the machine language programs have been documented with the excellent Macro Assembler and Text Editor (ASSM/TED) from Eastern House software (see my review in COMPUTE #1, p100). When I started messing with KIM several years ago, my programs were mostly hand assembled. This task has been made much easier by using ASSM/TED.

The first program is an implementation of a KIM real-time clock (sometimes called a tick counter). I have whimsically referred to it as a 'jeffrey counter' after a former student of mine. Every 100 milli-\* seconds a location-in page zero is incremented. By peeking at this location one can time external events up to about 25 seconds. We have used it to

0100 :

tell when to take readings from an analog-todigital converter. The clock can be started, stopped or read under program control. A source listing of the program is shown in figure 1. An example of a BASIC program which uses the tick counter is shown in figure 2.

In order for this program to work one external connection needs to be made. The counter is interrupt driven and requires PB7 on the application connector (A - 15) to be connected directly to IRQ (E - 4). The program sets PB7 as an input line and initializes the IRQ vectors at \$17FE/\$17FF to point to the clock service routine. For convenience I have modified KIM Microsoft BASIC to execute a preamble which, among other things, sets up these vectors before jumping to the normal start of BASIC.

The second program is an enhancement to KIM Microsoft BASIC. Support is added for a terminal (e.g. ASR 33 Teletype) which used the X - ON/X - OFF protocol to start and stop a paper tape reader. Over the years I had accumulated a number of programs on paper tape which I wanted to use with KIM BASIC. As supplied the BASIC software did not read paper tapes reliably and I had no desire to key in long programs again. I waded through a dissassembly of BASIC and found two calls to a subroutine which could be called "input a line".

```
0110 JINTERRUPT SERVICE ROUTINE FOR REAL-TIME CLOCK
                 0120 ; (TICK COUNTER) . ENHANCEMENT TO KIM MICROSOFT
                 0130 ; BASIC. 1/10 SEC PER TIC.
                 0140 3
                 0150 JHARVEY B. HERMAN
                 0160 3
                 0170 ; REQUIRES CONNECTION OF IRQ TO PB7.
                 0180 ; SET ALL PB PINS AS INPUT. SET ORIGINAL COUNT
                 0190 JAND DIVIDE RATE(/1024) OF 6530 TIMER.
                 0200 | START TICKING-POKE 5891.0: POKE 5903.98
                 0210 ; DI SABLE IRQ(OTHER WAYS POSSIBLE).
0220 ; STOP TICKING-POKE 5894,98
                 0230 JREAD TICK COUNTER-PEEK(224)
                 0240 ; RESET STOPS CLOCK.
                 0250 J
                 0260 TICK
                                   . DE $E0
                                                 FREE LOCATION PAGE ZERO
                                                 $1/10 SEC.
                 0270
                      COUNT
                                  .DE $62
                                  .DE $170F
                                                 ; DIVIDE BY 1024(INT. EN.)
                 0280
                      CLKKTE
                                                 KIM IRQ INTERRUPT
                 0290 IRQL
                                  .DE $17FE
                 0300 IRQH
                                  . DE $17FF
                                                      VECTORS
                 0310 3
                 0320 JINITIALIZATION ROUTINE
                      SET UP VECTORS AND ZERO TICK COUNTER
                 0330
                 0340 ;LOCATE ANYWHERE CONVENIENT
                 0350
                                   .BA $4368
                      JOTHER CODE ABOVE IN MY VERSION
                 0360
4368- A9 DA
                 0370
                                  LDA FINTER
436A- 8D FE 17
                 0380
                                  STA IRQL
436D- A9 02
                 0390
                                  LDA #H. INTER
436F- 8D FF 17
                 0400
                                  STA IRQH
4372- A9 00
                 0410
                                  LDA #00
STA *TICK
4374- 85 E0
                 0420
                 0430 JOTHER CODE BELOW IN MY VERSION
                 0440
                 0450 JINTERRUPT HERE ON TIMEOUT
                 0460
                                   -BA $2DA
02DA- 48
                 0470 INTER
                                  PHA
02DB- EA
                                  NOP
                                        JHIDE MY I GNO RANCE
                 0480
02DC- E6 E0
                                  INC *TICK
                 0490
02DE- A9 62
                 0500
                                  LDA #COUNT
02E0- 8D 0F 17
                 0510
                                   STA CLKKTE
02E3- 68
                 0520
                                  PLA
02E4- 40
                 0530
                                  RTI
                 0540
                                   . EN
```



# Skyles Electric Works

# Presenting the Skyles MacroTeA

# The Software Development System For the Serious Programmer

# **Text Editor**

To help you write your program, MacroTeA includes a powerful text editor with 34 command functions:

NUMBER Automatically renumbers lines.

FORMAT Outputs text file in easy-to-read columns

Copies a line or group of lines to a new COPY

Moves a line or group of lines to a new MOVE

DELETE Deletes a line or group of lines.

CLEAR Clears the text file.

PRINT Prints a fine or group of lines to

PUT Saves a line or group of lines of text on

the tape (or disc)

Loads a previously saved line or group of lines of text from the tape (or disc).

DUPLICATE Copies text file modules from one tape recorder to the other. Stops on specific

modules to allow changes before it is dupli-cated. This command makes an unlimited length program (text file) practical.

HARD Prints out text file on printer

Assembles text file with or without a listing. ASSEMBLE Assembly may be specified for the object code

(program) to be recorded or placed in RAM

Does second pass of assembly. Another command that makes unlimited length text files (source code) practical,

RUN Runs (executes) a previously assembled

SYMBOLS Prints out the symbol table (label file).

Gives complete control of the size and location table) and relocatable buffer.

Gives complete access to the eleven DOS commands; PUT GET NEW INITIALIZE DIRECTORY COPY DUPLICATE SCRATCH VALIDATE RENAME ERROR REPORT

EDIT Offers unbelievably powerful search and replace capability. Many large computer assemblers lack this sophistication.

Searches text file for defined strings. Optionally prints them and counts them; i.e., this command. The conditional assembly pseudo-ops are:

counts number of characters in text file. MANUSCRIPT Eliminates line numbers on PRINT and HARD

command. Makes MacroTea a true and power ful Text Editor BREAK Breaks to the Monitor portion of MacroTea A return to Text Editor without loss of text

is possible.

Improves or tailors MacroTea's Text Editor USER

# Fast...Fast Assembler

Briefly, the pseudo-ops are:

Commands the assembler to begin placing assembled · BA code where indicated

Commands the assembler to continue assembly unless certain serious errors occur. All errors are printed out.

Commands the assembler to start listing source (text file) from this point on.

• LC Commands the assembler to stop list source (text file) from this point in the program

CT Commands the assembler to continue that source

os Commands the assembler to store the object code in

OC Commands the assembler to not store object code in

 MC Commands the assembler to store object code at local tion different from the location in which it is assembling object code

• SE Commands the assembler to store an external address.

DS Commands the assembler to set aside a block of storage.

. BY Commands the assembler to store data

· SI Commands the assembler to store an internal address.

Commands the assembler to calculate an external label • DE expression

expression

Informs the assembler that this is the end of the

A directive not a pseudo-op, directs the assemblers to

Commands the assembler to eject to top of page on

# **Macro Assembler**

The macro pseudo-ops include:

. EJ

ME This is end of a macro instruction definition. Do not output macro-generated code in source

listing Do output macro-generated code in source

# Conditional Assembler

If the label expression is equal to zero. assemble this block of source code (text file). If the label expression is not equal to zero, assemble this block of source code (text file). If the label expression is positive, assemble this

block of source code. IMI If the label expression is negative, assemble this block of source code

This is the end of a block of source code.

# **Enhanced Monitor**

By having 16 powerful commands.

Automatic MacroTeA cold start from Monitor. Automatic MacroTeA warm start from Monitor.

Loads from tape object code program

S Saves to tape object code between locations

n Disassembles object code back to source listing.

Displays in memory object code starting at selected location. The normal PET screen edit may be used to change the object code.

Displays in register. Contents may be changed using PET screen edit capabilities

Hunts memory for a particular group of object

Allows you to walk through the program one step

Breakpoint to occur after specified number of passes past specified address

Start on specified address. Quit if STOP key or

Transfers a program or part of a program from one memory area to another

Go!! Runs machine language program starting at selected location

Exits back to BASIC.

Display memory and decoded ASCII characters.

Pack (fill) memory with specified byte.

# What are the other unique features of the MacroTeA?

Labels up to 10 characters in length

. 50 different symbols to choose from for each character

10<sup>16</sup> different labels possible

Create executable object code in memory or store on tape

Text editor may be used for composing letters, manuscripts, etc.

Text may be loaded and stored from tape or disc

Powerful two-cassette duplicator function

String search capability

Macros may be nested 32 deep

25 Assembler psuedo-ops

5 Conditional assembler psuedo-ops

40 Error codes to pinpoint problems

16 Error codes related to Macros

Warm-start button

Enhanced monitor with 16 commands

Truly, there is simply no other system of this magnitude at anywhere near this price.

(With any Skyles Memory Expansion System, \$375.00

California residents please add 6% or 6.5% sales tax as required

VISA, MASTERCHARGE ORDERS CALL (800) 538-3083 (except California residents) CALIFORNIA ORDERS PLEASE CALL (408) 257-9140

Skyles Electric Works Mountain View, CA 94041

231 E South Whisman Road (415) 965-1735

The change I made was to send out an X - ON character (with added code in page 2) before jumping to this subroutine. My paper tape reader will begin reading upon receipt of this character.

It was necessary to make one further change in order for KIM to punch BASIC program tapes that would read back properly. The tape reader must stop after carriage return while BASIC "digests" a line. Therefore the X - OFF character (stop reading) must be included in the data stream. I found a call to BASIC's output routine immediately after loading the accumulator with "CR" (hex 0D). I changed this to a jump to code, again in page 2, which outputs X - OFF and CR before continuing as before. Later when the teletype reads the X - OFF character on tape it shuts off but does not stop immediately and reads one additional character (CR). Return sets the BASIC interpreter off and running. In a short time, after digesting the line, BASIC

0100 :

sends the X - ON character asking for more data. Only one *caveat* - remember to type control/0 before and after reading tapes so the teletype will only single space.

I hope these additional programs will be found useful. As always, if you have any questions I will be happy to respond if you include a SASE.

```
10 REM EXAMPLE PROGRAM TO PRINT A NUMBER
20 REM ONCE EVERY 10 SECONDS
30 POKE 5903,98: REM START CLOCK
40 FOR I = 1 TO 10
50 POKE 224,0: REM ZERO CLOCK
60 IF PEEK (224) <100 THEN 60
70 PRINT I;
80 NEXT I
90 POKE 5894,98: REM STOP CLOCK
100 END
```

```
0110 ;X-0N/X-OFF ENHANCEMENT TO
                 0120 ; KIM MICROSOFT BASIC
                 0130 ; SERIAL NUMBER 9011
                 0140
                 0150 SHARVEY B. HERMAN
                 0160 3
                 0170 ; SENDS X-ON(HEX 11) TO TERMINAL BEFORE JUMPING TO 0180 ; "INPUT A LINE". TERMINALS WITH THIS FEATURE WILL
                 0190 ; AUTOMATICALLY START READING PAPER TAPE. WHEN AN
                 0200 ;X-OFF(HEX 13) IS READ, THE TAPE READER CONTROL
                 0210 ; WILL TURN OFF AND THE READER WILL COAST AND
                 0220 ; TRANSMIT ONE EXTRA CHARACTER.
                 0230
                 0240 JPUNCHES PAPER TAPE(BY LIST) WITH X-OFF/CR/LF/
                 0250 ; NULL(S) AS END OF LINE FORMAT-
                 0260
                 0270 ; NULL(S) CORRECTION(NECESSARY FOR EARLY VERSIONS
                 0280 :OF BASIC) .
                 0290 ;
                                                 ;KIM OUTPUT ROUTINE
;BASIC "INPUT A LINE"
                 0300 OUTCH
                                   .DE SIEAO
                 0310 INPUT
                                   .DE $2426
                 0320 OUTPUT
                                   .DE $2A3A
                                                  BASIC OUTPUT ROUTINE
                                   .DE $29D1
                 0330 LDA0
                                                 ; INSTRUCTION LDA #00
                 0340
                 0350 ; INTERCEPT CALLS TO "INPUT A LINE"
                                   -BA $2351
                 0360
2351- 20 C8 02
                 0370
                                   JSR XON
                 0380
                                   . BA $2AB6
2AB6- 4C C8 02
                 0390
                                   JMP XON
                 0400 JOUTPUT X-ON CHARACTER
                 0410
                                   .BA $208
02C8- A9 11
                 0420 XON
                                   LDA #$11
                                                 X-ON
02CA- 20 A0 1E
                 0430
                                   JSR OUTCH
                                                 JOUT TO TERMINAL
02CD- 4C 26 24
                                                 JINPUT A LINE
                 0440
                                   JMP INPUT
                 0450 ; INTERCEPT CALLS TO OUTPUT CR
                                   -BA $29C3
                 0460
29C3- 20 D0 02
                                   JSR XOFF
                 0470
                 0480 JOUTPUT X-OFF/CR CHARACTERS
                 0490
                                   . BA $2D0
02D0- A9 13
                 0500 XOFF
                                   LDA #513
                                                 JX-OFF
02D2- 20 3A 2A
                 0510
                                   JSR OUTPUT
                                                 ; BASIC OUTPUT ROUTINE
02D5- A9 0D
                 0520
                                   LDA #50D
                                                 J CR
02D7- 4C 3A 2A
                                   JMP OUTPUT
                 0530
                 0540 ; CORRECT NULL(S) ERROR IN EARLY VERSION
                 0550 JOF BASIC. A WAS DESTROYED BY OUTPUT AND MUST
                 0560 ; BE LOADED AGAIN WITH ZERO.
                                   -BA $29D7
                 0570
29 D7- D0 F8
                 0580
                                   BNE LDAG
                 0590
                                   . EN
```

# **FACTORY PRICING**

IN STOCK!

IMMEDIATE DELIVERY!

ALL MOS TECHNOLOGY MPS 6500 ARRAYS---PLUS

- MPS 655O RAM for PET
- MPS 653O-OO2, -OO3 for KIM-1
- MANUALS
- KIM-1 MICROCOMPUTER
- KIM-3 8K STATIC RAM MEMORY BOARD
- KIM-4 MOTHERBOARD
- KIM PROMMER KIM-1 & 4 Compatable Eprom Programmer
- KIMATH Chips with Listing
- KIMEX-1 EXPANSION BOARD KIM-1 Plugable PROM, Ram and I/O Board
- RS-232 ADAPTER For KIM-1
- POWER SUPPLIES

# STANDARD MICROSYSTEMS

**★FLOPPY DISC DATA HANDLER ★**UART's **★BAUD RATE GENERATORS** ★CRT CONTROLLERS

# **FALK-BAKER ASSOCIATES**

382 FRANKLIN AVE • NUTLEY, NEW JERSEY 07110 (201) 661-2430

WRITE, CALL, OR RETURN OUR COUPON FOR CATALOGUE AND PRICE LISTS.

# SYM-1 Home Warning System

A. M. MacKay 600 Sixth Avenue West Owen Sound, Ontario N4K 5E7

If you have a C.R.T. hooked up to your SYM-1, this program and a couple of dollars worth of parts will let you experiment with a home warning system, and may help you learn a bit about your computer.

Once the hardware shown in figures 1 to 3 is connected, load the program and hit "RUN START" if you have an assembler or G 200 CR if you don't. Then as long as the old homestead is devoid of marauders, catastrophes and other unthinkables your screen will steadily and quietly tell you that everything is O.K. However, if one or more of the sensors detects any of the aforementioned nasties, a siren sounds and a message flashes on the screen telling you the nature and location of the problem(s).

The program starts by clearing the screen and displaying the "EVERYTHING IS O.K." message. It then polls the sensors, one at a time, beginning with PB0. As soon as it finds an active sensor, it clears the "O.K." message and displays the correct warning, then checks the remaining sensors. When all sensors have been checked and messages have been displayed for all active sensors, the siren sounds once and the polling process is repeated. The warnings and the siren will continue until all the sensors are turned off, at which time the "EVERYTHING IS O.K." message re-appears and polling of the sensors

resumes.

For this experiment four switches are used as input sensors. In practice,

0690

TEST4

```
******************
      ;
0010
0020
      ;
0030
      ;
               **
                       HOME WARNING SYSTEM
0040
               * * *
                            SYM-1 COMPUTER
0050
                       FOR
0060
0070
                       BY A. M. MACKAY
                       600 SIXTH AVE. WEST
0080
                       OWEN SOUND, ONTARIO
0090
      :
0100
                       CANADA
                                    N4K 5E7
      ;
0110
0120
0130
0140
0150
      ;
                      * DEFINITIONS
0160
      :
0170
                  .DE SACOO
0180
      STATUS
                  .DE $A663
0190
      OUTVEC
0200
                  * * * INITIATE * * *
0210
0220
                  LDA #SF0
                                 SET DDRB
0230
      START
                  LDA STATUS+2 : FOR INPUT
0240
                                 JTURN OFF
0250
                  LDA #$00
0260
                  STA STATUS
                                    SPEAKER
0270
      ;
                  * * * SENSOR POLL ROUTINE * *
0280
      ;
0290
                                 ;PRINT "ALL O.K." MESSAGE
0300
      CLEAR
                  JMP OK
                                 ;LOOK AT SENSORS
0310
      POLL
                  LDA STATUS
0320
                  AND #$0F
                                    IF ONE IS ON
0330
                  BNE TESTI
                                      GO TO TESTI
0340
                  JMP POLL
                                 JELSE GO TO POLL
0350
0360
                      * SIGNAL PROCESSING ROUTINE *
0370
                  JSR POSIT
                                 ; POSITION MESSAGE ON SCREEN
      TESTI
0380
                  LDA STATUS
0390
                                 ;LOOK AT SENSORS
0400
                                 ; MASK OFF ALL BUT IST
                  AND #501
0410
                  BEQ TEST2
                                 ; NOT ON? GO TO TEST2
0420
                  JSR SPACE
                                 ON? PROCESS SIGNAL
0430
                  LDX #0
                                 ; INDEX FOR MESSAGE #1
                  LDA TABLIX
      MESS1
                                 GET CHARACTERS
0440
0450
                  JSR OUTVEC
                                 WRITE ON CRT
                                 INEXT CHARACTER
0460
                  INX
                  CMP #500
                                 ; LAST ONE?
0470
0480
                                 JNO? GET NEXT
                  BNE MESSI
                                 ;YES? TEST FOR
0490
      TEST2
                  LDA STATUS
0500
                  AND #$02
                                    SENSOR #2
0510
                  BEQ TEST3
                                      ETC .
0520
                  JSR SPACE
0530
                  LDX #0
0540
      MESS2
                  LDA TAB2,X
0550
                  JSR OUTVEC
0560
                  INX
0570
                  CMP #500
0580
                  BNE MESS2
0590
      TEST3
                  LDA STATUS
                                ;TEST FOR
                                    SENSOR #3
0600
                  AND #$04
0610
                  BEQ TEST4
                                      ETC .
                  JSR SPACE
0620
0630
                  LDX #0
0640
      MESS3
                  LDA TAB3,X
0650
                  JSR OUTVEC
0660
                  INX
0670
                  CMP #$00
0680
                  BNE MESS3
```

JTEST FOR

LDA STATUS

# LET THE FIRST MATE EASE YOUR MICROCOMPUTER APPLICATIONS/TRAINING **EXPERIMENTATION**

Mounted on the SYM-1\*, the FIRST MATE provides ready access to address, data and control busses, and up to 35 bits of I/O plus control lines. Designed to serve the interfacing/prototyping needs of students, hobbiests and practicing engineers, the FIRST MATE interfaces to the



SYM-1 Expansion (E), Application (A) and Auxiliary Application (AA) connectors via one to three SECOND MATEs and 40-conductor ribbon cables. The I/O and bus lines are available at the onboard socket strip. Space is provided for up to three additional socket strips. The FIRST MATE is electrically compatible with the KIM-1\* and AIM-65\* microcomputers. Available from MicroMate, P.O. Box 50111,

Indianapolis, IN 46256.

MM-1 The FIRST MATE plus one SECOND MATE and one 40-conductor ribbon cable ..\$87.50 MM-2 Additional SECOND MATE . . . . . . . . \$15.00 MM-3 Additional 40-conductor ribbon cable \$10.00

### ColorMate by MicroMate

- available 3rd gtr. 1980 KIM, SYM, AIM compatible
- based on Motorola 6847 video display generator
- applications range from two-page alphanumeric/semi-graphic terminal to full graphics mode • write for free details.

Add 2% for shipping to continental U.S.A. Others add 10%. Indiana residents add 4% sales tax. KIM-1 is a product of MOS Technology AIM-65 is a product of Rockwell International \*SYM-1 is a product of Synertek Systems Corp.

# COMPUTE'S BOOK CORNER

We Now Have One of the Best Collections of 6502 Resource Materials Around:

Best of The PET Gazette

\$10.00

Collected PET User Notes Volume 1, Issues 2 - 7

**\$9.00** 

Volume 2, Issue 1

Volume 1, Issues 1 - 6

Volume 2, Issues 1 - 6

Volume 3, Issues 1 - 5

\$1.50

All 7 issues

\$10.00

65O2 User Notes

\$ 6.00 \$ 6.00 \$10.00

All 17 Issues

\$20.00

MC/VISA Accepted Add \$2.00 shipping & handling COMPUTE, P.O. Box 5119, Greensboro, NC 274O3

WACHINE LANGUAGE PROGRAMS FOR: \*AIM \*SYM \*KIM \*PET \*APPLE \*OSI & ANY 5502 SYSTEM

FOLIO

A FILE GRIENTED LANGUAGE • A PSEUDO-CODE INTERPRETER • SUPPORTS 27
FUNCTIONS WHICH SIMPLIFY DATA MANDLING • SUPPORTS FILES WITH UP TO 254 RECORDS
WITH UP TO 254 FIELDS WITH UP TO 80 CHARACTERS • FIELD SIZE IS VARIABLE FROM ONE
RECORD TO ANOTHER • BUILT-IN KEY SORT FUNCTION • FOLIO INTERPRETER COCCUPIES ONLY
1.25K RAW OR ROW • TYPICAL FOLIO PROGRAMS TAKE LESS THAN TK • DOES NOT REQUIRE
BASIC, CP/W•, CBASIC\*, 48K OR DISKS • WITH USER'S MANUAL, PROGRAMMER'S WANNAL &
COMMENTED SOURCE LISTING

### FOLIO PROGRAMS: =

- FILE CABINET A MULTI-PURPOSE DATA STORAGE AND RETRIEVAL PROGRAM ONLY TAKES 320 BYTES MENU DRIVEN SELECT RECORDS KEYED BY ANY FIELD SORT CHOICE OF REPORT FORMATS USE FOR MAILING LIST, INVENTORY, EMPLOYEE DATA, ETC •
- BUDGET FOR HOUSEHOLD BUDGET PLANNING PRINTS A 12 MONTH ACCOUNTING WITH UP TO 20 EXPENSE OR INCOME ITEMS WITH MONTHLY TOTALS AND BALANCE MENU DRIVEN EASY TO CHANGE ITEM NAMES OR AMOUNTS REQUIRES 64 OR 72 CHARACTER LINE TERMINE.
- CHECKBOOK CHECKBOOK

  ENTER CHECKS AS YOU WOULD IN YOUR CHECK REGISTER PLUS A
  CODE NUMBER FOR UP TO 256 CATECORIES SUCH AS "FOOD", "MEDICAL", ETC. • PRINTS THE
  STATEWENT WITH AUNNING BALANCE FOR SELECTED DATES OR IN NUMERICAL ORDER • PRINTS
  AND TOTALS CHECKS WITH SELECTED CODE # - FOR SELECTED DATES • PRINTS CODE TOTALS

### PROGRAMS: == 6502

- TEA TINY EDITOR/ASSEMBLER CHARACTER ORIENTED EDITOR SINGLE PASS ASSEMBLER MAY BE USED SEPARATELY TO CONSERVE RAM 14 EACH CLOSELY USES MOS UNEUDITOR COMES WITH USER'S MANUAL AND COMMENTED SOURCE LISTING \$20.00
- DISASSEMBLER DISASSEMBLER DISPLAYS SYMBOLIC LABELS AND OPERANDS FROM SYMBOL TABLE GENERATED BY TEA (ABOVE) \* OR DISPLAYS ADDRESS VALUE \* GREAT FOR DEBUGGING MACHINE CODE \* WITH USERS' MANUAL AND COMMENTED SOURCE LISTING \$10.00
- ROBOT INTERACTIVE PROGRAMMING LANGUAGE TO CONTROL ROBOT, PLOTTER OR C CURSOR & USER DEFINED COMMANDS & COMMAND SUBROUTINES & COMES WITH CRY ROUTINES WITH USER'S MANUAL AND COMMENTES SOURCE LISTING (1.5K). ROBOT
- MUSIC MUSIC INTERACTIVE PROGRAMMING LANGUAGE FOR THE CREATION OF PATTERNS OF SOUND "MUSIC" • A COMPOSITION TOOL • NOT A NOTE TABLE COMPILER OR "PIANO ROLL" • COMPLEX HIERARCHIES OF USER DEFINED FUNCTIONS - STRINGS OF MUSICAL EVENTS, WHICH CAN BE CALLED LIKE SUBROUTINES, ALLOW THE PROGRAMMING OF SURPRISINGLY INTRICATE COMPOSITIONS • WITH USER'S MANUAL AS COMMENTED SOURCE LISTING 500.00
- ALL PROGRAMS WORK IN A 4K SYSTEM MANUALS CONTAIN INSTRUCTIONS FOR MODIFICATION USER EXTENSION, RELOCATION, AND INPUT & OUTPUT INTERFACING FOR \$502 PROGRAMMERS
- CASSETTE TAPE (KIM-1 "HYPERTAPE") -
- MICHAEL ALLEN: 6025 KIMBARK: CHICAGO, ILLINOIS 60637 ORDER FROM:

any sensor that will put out 5V under the appropriate conditions will do the job, and the program can be extended to handle any reasonable number of sensors.

The program as written uses PB0 to PB3 of U29 as inputs, and PB7 with its buffer as the speaker output. Figure 1 shows how to hook up buffer B7 for this application. Although it looks complicated, changing B7 is easy. All you have to do is remove one jumper wire and add two resistors and one diode. However, if you prefer, you can forget about buffer B7 and construct a similar speaker system externally. Again, in real life, PB7 would be connected to a large amplifier and speaker.

Figure 2 shows how to attach the speaker, and figure 3 shows one way to use switches as simulated sensors. The speaker volume control, VR1, is optional, but it's a good idea to use it because without it the siren can shatter your wife's teeth.

The messages should, of course, be changed to suit your particular application. If you have an assembler such as RAE, this is easy. If not, you will have to get an ASCII code table and substitute the message code as required. The messages shown in the listing are for a 64x16 screen, so if yours is different, change the number of "0A"s and "20"s to suit your requirements.

Sound is produced by toggling the speaker on and off, with a delay between the toggles. The length of the delay determines the frequency. The siren sound is produced by shortening the delay slightly each time the speaker toggles, thus giving a steadily increasing frequency. For more information on sirens and other experiments read Rodnay Zak's "6502 Application Book" published by Sybex.

This program uses the SYM-1 as a dedicated con troller, so it can't be used for other purposes while the program is running. If you want the warning system working while you use your SYM-1 for other things, a new program using interrupts must be written. But that's another ballgame.

```
0700
                  AND #$08
                                 ;
                                    SENSOR #4
0710
                  BNE LAST
                                       ETC .
0720
                  JMP MESSX
0730
      LAST
                  JSR SPACE
0740
                  LDX #0
0750
      MESS4
                  LDA TAB4,X
                  JSR OUTVEC
0760
0770
                  INX
0780
                  CMP #500
0790
                  BNE MESS4
0800
                  JMP SIREN
                                 :TEST FOR
0810
      MESSX
                  LDA STATUS
                  AND #$0F
                                    ANY SENSORS
0820
                                 ; IF NONE, BACK TO POLL
0830
                  BEQ AGAIN
                                 ;ELSE SOUND SIREN
0840
                  JMP SIREN
                                 ; POSITION
0850
      OK
                  JSR POSIT
                  LDX #0
                                    MESSAGE
0860
      AGAIN
                  LDA TABS.X
                                 ;DISPLAY
0870
      ALLOK
                                    "EVERYTHING O.K."
0880
                  JSR OUTVEC
                                       MESSAGE
0890
                  INX
                  CMP #$00
0900
0910
                  BNE ALLOK
                                 ;TURN OFF
0920
                  LDA #$00
                  STA STATUS
0930
                                    SPEAKER AND
                  JMP POLL
                                      RESUME POLLING
0940
0950
                      * SIREN ROUTINE * * *
0960
0970
                  LDA STATUS
                                 JANY SENSOR
0980
      SIREN
0990
                  AND #50F
                                    STILL ON?
                  STA *SCB
                                 ; IF YES, STORE IT
1000
                  BNE SCREAM
                                    AND START ALARM
1010
                  JMP CLEAR
                                 JELSE POLL AGAIN
1020
                                 FREQUENCY CONSTANT
1030
      SCREAM
                  LDA #$68
                  STA *SCA
                                    AT LOCATION SCA
1040
      YLOOP
                  LDY #$07
                                 DELAY CONSTANT
1050
1060
      SHRIEK
                   JSR SPKR
                                 JOGGLE SPEAKER
1070
                  DEY
1080
                       SHRIEK
                  BNE
1090
                  INC
                       *SCA
                                 ; INCREMENT
                  LDA *SCA
                                 ; FREQ. CONSTANT
1100
                  CMP #$B0
                                 JHIGHEST CONST .= $B0
1110
                  BNE YLOOP
1120
1130
                  LDA STATUS
                                 SANY
1140
                  AND #SOF
                                    SENSOR
1150
                  CMP *SCB
                                      CHANGE?
1160
                                 ; NO? KEEP SIREN GOING
                  BEQ SCREAM
                                 ;YES? ANY MORE
1170
                  LDA STATUS
1180
                  AND #SOF
                                    SENSORS ON?
1190
                                 ; NO? PRINT O.K. MESSAGE
                  BEQ SCREEN
1200
                  JMP POLL
                                 YES? PROCESS AGAIN
1210
      SCREEN
                  JMP CLEAR
1220
1230
                   * * * SUBROUTINES * * *
1240
1250
      SPKR
                  LDA #$80
                                 RESET
                  STA STATUS+2
1260
                                    DDRB AND
                                 :
                                       TOGGLE SPEAKER
1270
                  STA STATUS
                                 ;
1280
                  JSR DELAY
                                 WAIT AND
1290
                  LDA #500
                                 ;
                                    TOGGLE
1300
                  STA STATUS
                                      AGAIN
1310
                  JSR DELAY
                                 WAIT AGAIN
1320
                  RTS
1330
      DELAY
                                 CHANGE
                  LDX *$CA
1340
      XLOOP
                  INX
                                    FREQUENCY
                        ;
1350
                  CPX #$00
1360
                  BNE XLOOP
1370
                  RTS
1380
      POSIT
                  LDX #0
```

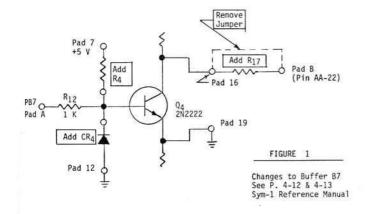
1690

```
1390
     MOVE
                 LDA TAB6,X
                               ; POSITION
1400
                 JSR OUTVEC
                                  MESSAGE
1410
                 INX
                      ;
                                    ON
                 CMP #$00
                                      SCREEN
1420
                 BNE MOVE
1430
1440
                 RTS
1450
     SPACE
                 LDX #0
                               POSITION
                 LDA TAB7.X
1460
     RIGHT
                               ;
                                  WARNING
1470
                 JSR OUTVEC
                                    MESSAGES
1480
                 INX
1490
                 CMP #$00
1500
                 BNE RIGHT
1510
                 RTS
1520
     ;
                 * * * MESSAGES * *
1530
     ;
1540
     ;
                     1 1 1 1
                              WATER IN BASEMENT
1550
     TAB I
                                                 ] ] ] * $00
     TAB2
                         + + DOG NEEDS TO GO OUT + + + * $00
1560
                        # # THIEF IN WINE CELLAR # # * $00
     TAB3
1570
                        * * MILKMAN IN WIFE"S BEDROOM *
1580
     TAB4
                 .BY
                     *
                 .BY '* * * 500
1590
                      ***********
                 .BY
1600
     TAB5
                      ****** $0D $0A $0A
1610
                 .BY
                 .BY
                         * * SYM-1 HOME WARNING SYSTEM '
1620
                     * * * * 50D $0A $0A
1630
                 .BY
                 .BY '> > >
1640
                                 EVERYTHING IS O.K.
                      '< < <' $0D $0A $0A '******
1650
                 .BY
                 .BY ************
1660
     TAB6
                 BY $0C $0D $0A $0A $0A $0A $00
1670
                 .BY $0D $0A $0A $20 $20 $20 $20 $20
1680
     TAB7
```

.BY \$20 \$20 \$00

.EN

Parts List For SYM-1 Home Warning System. R4 100K Resistor R17 10 Ohm Resistor R18 1K Resistor VR1 100 Ohm Potentiometer (Optional) C1 0.01 UF Capacitor CR4 Diode, 1N4148, 1N914 Or Equivalent SW1-4 Any SPDT Switches SPKI 8 Ohm Speaker, RS 40 -247 Or Equivalent



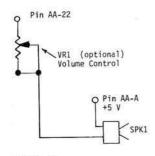
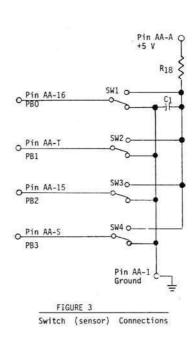
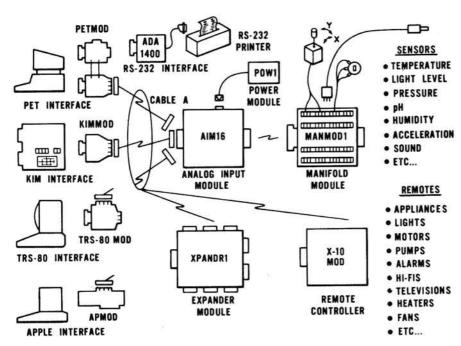


FIGURE 2 Speaker Connections



# MICROCOMPUTER MEASUREMENT and



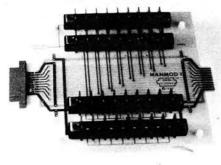
The world we live in is full of variables we want to measure. These include weight, temperature, pressure, humidity, speed and fluid level. These variables are continuous and their values may be represented by a voltage. This voltage is the analog of the physical variable. A device which converts a physical, mechanical or chemical quantity to a voltage is called a sensor.

Computers do not understand voltages: They understand bits. Bits are digital signals. A device which converts voltages to bits is an analog-to-digital converter.

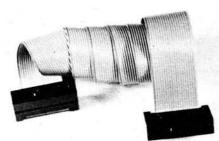
Our AIM 16 (Analog Input Module) is a 16 input analog-to-digital converter.

The goal of Connecticut microComputer in designing the uMAC SYSTEMS is to produce easy to use, low cost data acquisition and control modules for small computers. These acquisition and control modules will include digital input sensing (e.g. switches), analog input sensing (e.g. temperature, humidity), digital output control (e.g. lamps, motors, alarms), and analog output control (e.g. X-Y plotters, or oscilloscopes).

# Connectors







The AIM 16 requires connections to its input port (analog inputs) and its output port (computer interface). The ICON (Input CONnector) is a 20 pin, solder eyelet, edge connector for connecting inputs to each of the AIM16's 16 channels. The OCON (Output CONnector) is a 20 pin, solder eyelet edge connector for connecting the computer's input and output ports to the AIM16.

The MANMOD1 (MANifold MODule) replaces the ICON. It has screw terminals and barrier strips for all 16 inputs for connecting pots, joysticks, voltage sources, etc.

CABLE A24 (24 inch interconnect cable) has an interface connector on one end and an OCON equivalent on the other. This cable provides connections between the uMACSYSTEMS computer interfaces and the AIM 16 or XPANDR1 and between the XPANDR1 and up to eight AIM 16s.

# **Analog Input Module**



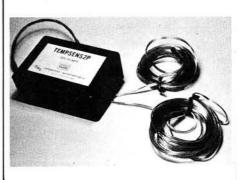
The AIM 16 is a 16 channel analog to digital converter designed to work with most microcomputers. The AIM16 is connected to the host computer through the computer's 8 bit input port and 8 bit output port, or through one of the uMAC SYSTEMS special interfaces.

The input voltage range is 0 to 5.12 volts. The input voltage is converted to a count between 0 and 255 (00 and FF hex). Resolution is 20 millivolts per count. Accuracy is 0.5% ± 1 bit. Conversion time is less than 100 microseconds per channel. All 16 channels can be scanned in less than 1.5 milliseconds.

Power requirements are 12 volts DC at 60 ma.

The POW1 is the power module for the AIM16. One POW1 supplies enough power for one AIM16, one MANMOD1, sixteen sensors, one XPANDR1 and one computer interface. The POW1 comes in an American version (POW1a) for 110 VAC and in a European version (POW1e) for 230 VAC.

# **TEMPSENS**

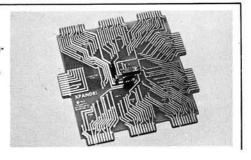


This module provides two temperature probes for use by the AIM16. This module should be used with the MANMOD1 for ease of hookup. The MANMOD1 will support up to 16 probes (eight TEMP-SENS modules).

Resolution for each probe is 1°F.

# XPANDR1

The XPANDR1 allows up to eight Input/
Output modules to be connected to a computer at one time. The XPANDR1 is connected to the computer in place of the AIM16. Up to eight AIM16 modules are then connected to each of the eight ports provided using a CABLE A24 for each module. Power for the XPANDR1 is derived from the AIM16 connected to the first port.



# **IONTROL** for PET, Apple, KIM, and AIM



# Computer Interfaces and Sets





For your convenience the AIM16 comes as part of a number of sets. The minimum configuration for a usable system is the AIM16, one POW1, one ICON and one OCON. The AIM16 Starter Set 2 includes a MANMOD1 in place of the ICON. Both of these sets require that you have a hardware knowledge of your computer and of computer interfacing.

For simple plug compatible systems we also offer computer interfaces and sets for several home computers.

INTRODUCING SUPER X-10 MODULE

Open a door or window and turn on a light, tape recorder, alarm!

Control lab equipment. CLOSE THE LOOP on the real world.

# AN INEXPENSIVE CONTROL SOLUTION FOR

HOME SECURITY
ENERGY CONSERVATION
GREENHOUSES
ENVIRONMENTAL CONTROL
INDUSTRIAL CONTROL
LABORATORIES

SUPER X-10 MOD SPECS

- Remote controller
   Controls up to 256 different remote
   devices by sending signals over the
   house wiring to remote modules. Uses
   BSR remote modules available all over
   the USA (Sears, Radio Shack, etc.).
   Does not require BSR control module.
   Does not use sonic link.
- Clock/calendar
   Time of day hours, minutes, seconds
   Date month, day automatically corrects for 28,29,30 and 31 day months.

   Day of the week.
- Digital inputs/outputs
   inputs TTL levels or switch closures.
   Can be used as triggers for stored sequences.
   outputs TTL levels



PLUS: CLOCK, CALENDAR, REMOTE SEQUENCE TRIGGERS



- 4. Computer interfaces S-100: Requires one 8-bit input port and one 8-bit output port. Requires cable assembly. PET, APPLE, TRS-80, KIM, SYM, AIM65: Plug-in sets available - no cable assembly required. Other: same as S-100
- Self-contained module in metal case with its own power supply. Physical size approximately 5X6X2.

Price (until April 30, 1980): \$199.00 (S-100), \$249.00 (other)

All prices and specifications subject to change without notice. Our 30-day money back guarantee applies.

AIM16 (16 channel-8 bit Analog	
Input Module)	179.00
POW1a (POWer module-110 VAC)	14.95
POW1e (POWer module-230 VAC)	24.95
ICON (Input CONnector)	9.95
0CON (Output CONnector)	9.95
MANMOD1 (MANifold MODule)	59.95
CABLE A24 (24 inch interconnect	
cable)	19.95
XPANDR1 (allows up to 8 Input or	
Output modules to be connected to	а

0utput modules to be connected to a computer at one time) 59.95
TEMPSENS2P1 (two temperature probes, 10°F to 160°F) 49.95
LIGHTSENS1P1 (light level probe) 59.95

The following sets include one AIM16, one POW1, one OCON and one ICON.

AIM16 Starter Set 1a (110 VAC) 189.00

AIM16 Starter Set 1e (230 VAC) 199.00

The following sets include one AIM16, one POW1, one OCON and one MANMOD1. AIM16 Starter Set 2a (110 VAC) 239.00 AIM16 Starter Set 2e (230 VAC) 249.00

The following modules plug into their respective computers and, when used with a CABLE A24, eliminate the need for custom wiring of the computer interface. PETMOD (Commodore PET) 49.95 KIMMOD (KIM, SYM, AIM65) 39.95 APMOD (APPLE II) 59.95 TRS-80 MOD (Radio Shack TRS-80) 59.95



# **Order Form**

CONNECTICUT microCOMPUTER, Inc. 150 POCONO ROAD BROOKFIELD, CONNECTICUT 06804 TEL: (203) 775-9659 TWX: 710-456-0052

The following sets include one AIM16, one POW1, one MANMOD1, one CABLE A24 and one computer interface module PETSET1a (Commodore PET -295.00 110 VAC) PETSET1e (Commodore PET -305.00 230 VAC) KIMSET1a (KIM, SYM, AIM65 -285.00 110 VAC) KIMSET1e (KIM, SYM, AIM65 -295.00 230 VAC) APSET1a (APPLE II - 110 VAC) 295.00 305.00 APSET1e (APPLE II - 230 VAC) TRS-80 SET1a (Radio Shack TRS-80 295.00 110 VAC)

305.00

TRS-80 SET1e (Radio Shack TRS-80

230 VAC)

SUBTOTAL			
Handling and shippin	g — add per ord	der	\$3.00
Foreign orders add 10	0% for AIR posta	age	
	add 7% sales	tax	
TOTAL ENCLOSED			
NAME			
COMPANY			
ADDRESS			
Home Street Street, Street Street, Street Street, Stre			
CITY			
STATE	1111111	ZIP	

# A Digital Cardiotachometer Marvin L. De Jong Department of Mathematics-Physics The School of the Ozarks Pt. Lookout, MO 65726 Implemented With The AIM 65

The circuit shown in Figure 1 and the computer program given in the listing may be used to measure the pulse (heartbeat) rate of a person and display this result (in heartbeats per minute) on the AIM 65 display. A modified version of a PASCO Photo-Plethysmograph (PASCO Scientific, 1933 Republic Avenue, San Leandro, CA 94577) was used to detect the pulses. You might be able to build your own photo-plethysmograph using suitable infared photodiodes and phototransistors (such as the Fairchild FPA106 array) for a lot less money, but be prepared to do some experimentation. The voltage fluctuation from the plethysmograph is amplified by an instrumentation amplifier. We used an Analog Devices (Route 1, Industrial Park, P.O. Box 280, Norwood, MA 02062) AD521. The negative pulses from the AD521 are fed to a 555 timer that acts as a Schmitt trigger circuit, producing a well-defined square pulse at the clock input of the 74LS74. The LED will turn off when a pulse is detected. In the circuit of Figure 1, the 2000 ohm potentiometer on the AD521 controls the gain, and it should be adjusted so that heartbeats cause the LED to flash. An osciolloscope is very useful for making circuit adjustments.

The time interval between two successive pulses to the clock input of the 74LS74 is measured by the computer, and this result is converted to heartbeats per minute. The T1 timer on the 6522 on the AIM 65 microcomputer is used to produce a train of pulses that are fed to one input of the 74LS00 NAND gate. the period of these pulses is 100 microseconds. The leading edge of the heartbeat pulse at the clock input of the 74LS74 flips the Q output to logic one, gating the pulses from PB7 onto PB6 where the T2 counter/timer on the 6522 counts them. They are counted until the leading edge of the next heartbeat pulse flops the Q output to logic zero, closing the gate. Thus, the computer contains the number of 100 microsecond pulses that occurred between two heartbeats. Since f = 1/T where f is the frequency of the heartbeats and T is the time interval between beats, then  $f = 10^{\circ}/N$  where N is the number of pulses counted by the T2 counter/ timer. Changing the units to pulses per minute gives  $f = 60 \times 10^4 / N$ .

We first describe the machine language subroutine called by the BASIC program. The instructions from \$0E00 to \$0E30 merely initialize the various 6522 registers. For example, T1 must produce a pulse train on PB7 and T2 must count pulses. A positive

transition on CB1 must set a flag, while reading Port B produces a one microsecond pulse on CB2, clearing the flip-flop. Starting with the instruction at \$0E30, the D-input of the flip-flop is set at logic one. Since the flip-flop was previously cleared, its output is currently at logic zero on the Q pin. The first heartbeat pulse reaching the flip-flop clock input sets the Q output to logic one. This transition is also detected by the instructions at \$0E37 through \$0E39, and as soon as it occurs, the program begins to watch the pulse count on T2.

Before switching the D-input of the flip-flop to logic zero in order to turn the gate off when the next heartbeat pulse arrives, the T2 counter is watched to allow approximately one-half a heartbeat period to elapse. It waits 0.0244 s to be exact (you may wish to decrease the value of the byte at \$0E44). The reason for waiting lies in the fact that the waveshape of the heartbeat pulse (at lease mine) has a secondary peek that can trigger the flip-flop if the gain is set a bit too high. So, we wait until this secondary pulse has been completed before catching the next heartbeat pulse. Bringing the D-input to logic zero allows the next clock pulse to switch Q to logic zero, closing the gate. The number of counts in T2 is obtained, and if T2 counted through zero, producing an interrupt (IRQ) request, the number of interrupts (counts exceeding 65536) are also obtained.

The BASIC program calls the machine language subroutine which then measures the number of 100 microsecond intervals between heartbeats. The BASIC program merely converts this number to a frequency and displays the result. Finally, it returns to measure another heartbeat period. Note that because of various time delays in processing the data, only every other heartbeat interval is measured.

I would not recommend that a novice experimenter with very little test equipment attempt to build this circuit. A number of adjustments are necessary and things like fluorescent lights can cause problems with the plethysmograph, in particular they can produce a 120 cycle modulation that triggers the circuit. The circuit does make a nice electronics project, and I am sure that improvements are possible. Of course, the circuit and the program are meant to be used for instructional purposes rather than in actual medical applications.

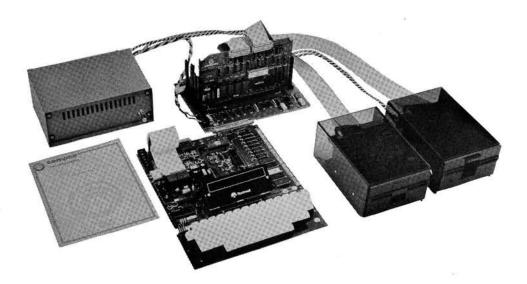
Besides being useful in teaching some simple biomedical instrumentation, this program and circuit



# compas microsystems

P.O. Box 687 224 S.E. 16th Street Ames, Iowa 50010 TWX 910-520-1166

# DAIM



DAIM is a complete disk operating system for the ROCKWELL INTERNATIONAL AIM 65. The DAIM system includes a controller board (with 4K operating system in EPROM) which plugs into the ROCKWELL expansion motherboard, packaged power supply capable of driving two 5 1/4 inch floppy drives and one or two disk drives mounted in a unique, smoked plastic enclosure. DAIM is completely compatible in both disk format and operating system functions with the SYSTEM 65. Commands are provided to load/save source and object files, initialize a disk, list a file, list a disk directory, rename files, delete and recover files and compress a disk to recover unused space. Everything is complete — plug it in and you're ready to go! DAIM provides the ideal way to turn your AIM 65 into a complete 6500 development system. Also available are CSB 20 (EPROM/RAM) and CSB 10 (EPROM programmer) which may be used in conjunction with the DAIM to provide enhanced functional capability. Base price of \$850 includes controller board with all software in EPROM, power supply and one disk drive. Now you know why we say —

There is nothing like a

DAIM

Phone 515-232-8187

0E74 40

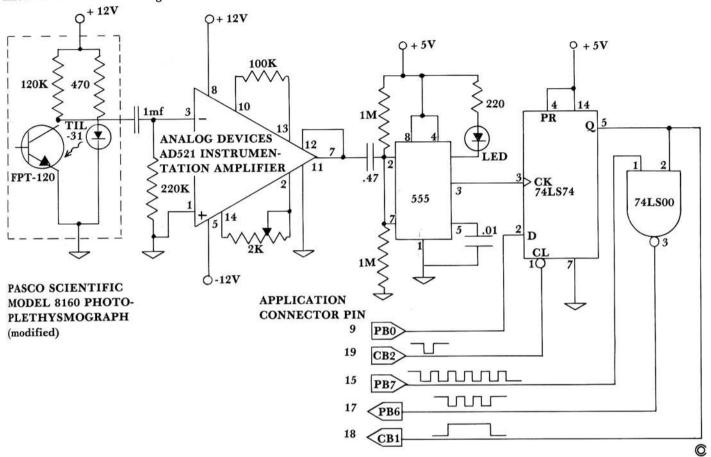
might be useful for experiments on factors that alter the heartbeat rate. What about that last cup of coffee you drank? Can you exert control over your pulse rate with your mind? What is the cause of the statistical fluctuation in heartbeat rates when a person is simply relaxed? What happened to your heartbeat rate when that pretty girl walked by?

```
DIGITAL CARDIOTACHOMETER PROGRAM
10 POKE 04,00; POKE 05,14
20 Y = USR(0)
30 X = 65536*PEEK(51) + 256*PEEK(50) + PEEK(49)
40 R = 600000/X
50 R = INT(R + .5)
60 PRINT R: "PULSES/MIN"
70 GO TO 20
80 END
0E00 A9 B0
                   START
                                    LDA $B0
                                                     Initialize PCR on the 6522. CB 2 in output
0E02 8D 0C A0
                                    STA PCR
                                                     pulse mode. Transition on CB1 sets flag.
0E05 A9 81
                                    LDA $81
                                                     Initialize DDRB so PB0 and PB7 are output
0E07 8D 02 A0
                                    STA DDRB
0E0A 8D 00 A0
                                    STA PBD
                                                     Set PB0 and PB7 to logic one.
0E0D CE 00 A0
                                    DEC PBD
                                                     Make D-input on flip-flop logic zero.
0E10 A9 E0
                                    LDA $E0
                                                     Set up ACR so T1 is in free-running mode
0E12 8D 0B A0
                                    STA ACR
                                                     and T2 counts pulses.
0E15 A9 A0
                                    LDA $A0
                                                     Set up IER so T2 produces interrupts when
0E17 8D 0E A0
                                    STA IER
                                                     it counts through zero.
0E1A A9 30
                                    LDA $30
                                                     Set period of pulse train from PB7 to be
0E1C 8D 06 A0
                                    STA T1LL
                                                     100 microseconds.
0E1F A9 00
                                    LDA $00
0E21 8D 05 A0
                                    STA T1LH
                                                     Start pulse train from PB7.
0E24 A9 00
                                    LDA $00
                                                     Clear interrupt counter.
0E26 85 33
                                    STA PLSHI
                                                     This location contains number of interrupts.
0E28 A9 FF
                                    LDA $FF
                                                     Initialize the T2 counter to count down
0E2A 8D 08 A0
                                    STA T2LL
                                                    from $FFFF.
0E2D 8D 09 A0
                                    STA T2CH
0E30 EE 00 A0
                                    INC PBD
                                                    Set D-input to logic one. Next pulse from
0E33 58
                                    CLI
                                                    plethysmograph will start timing.
0E34 AD 0D A0
                   WAIT
                                    LDA IFR
                                                     Check flag to see if timing has started.
0E37 29 10
                                    AND $10
                                                    Mask all except bit four of the IFR.
0E39 F0 F9
                                    BEQ WAIT
                                                    Loop here until a pulse starts the timing.
0E3B A9 00
                                    LDA $00
                                                    Clear PCR to prevent clearing the 74LS74.
0E3D 8D 0C A0
                                    STA PCR
0E40 AD 09 A0
                   LOAF
                                    LDA T2CH
                                                    Read the timer. Wait here until about
0E43 C9 F4
                                    CMP $F4
                                                    one-half the pulse period has passed
0E45 B0 F9
                                    BCS LOAF
                                                    before setting D-input to logic zero
0E47 CE 00 A0
                                    DEC PBD
                                                    at the next pulse.
0E4A AD 0D A0
                   LOITER
                                    LDA IFR
                                                    Read the flag register. Has the next
0E4D 29 10
                                    AND $10
                                                    pulse occurred?
0E4F F0 F9
                                    BEQ LOITER
                                                    No. Then wait here.
0E51 A9 FF
                                    LDA $FF
                                                    Yes. Then count the pulses that have
0E53 38
                                    SEC
                                                    occurred (from PB7 to PB6).
0E54 ED 08 A0
                                    SBC T2CL
                                                    Low order byte of PB7 pulse count.
0E57 85 31
                                    STA PLSLO
0E59 A9 FF
                                                    Get middle byte of PB7 pulse count.
                                    LDA $FF
0E5B ED 09 A0
                                    SBC T2CH
0E5E 85 32
                                    STA PLSMI
                                                    PLSHI, PLSMI, and PLSLO are read by the
0E60 78
                                    SEI
                                                    BASIC program.
0E61 4C D1 C0
                                   JMP BASIC
                                                    Return to BASIC program.
INTERRUPT ROUTINE: SET IRQ VECTOR TO $0E65
0E65 48
                   INTRPT
                                    PHA
                                                    Save accumulator on the stack.
0E66 A9 FF
                                    LDA $FF
                                                    Restart T2 by reloading it.
0E68 8D 09 A0
                                    STA T2CH
0E6B 38
                                    SEC
                                                    Now increment the interrupt counter, PLSHI.
0E6C D8
                                    CLD
0E6D A9 00
                                    LDA $00
0E6F 65 33
                                    ADC PLSHI
0E71 85 33
                                   STA PLSHI
                                                    Result into PLSHI.
0E73 68
                                    PLA
                                                    Recall accumulator contents.
```

RTI

Return to the machine language subroutine.

Figure 1. Interface circuit for the digital cardiotachometer.



## AIM-65 **COMPLETE SYSTEM UPGRADING**

#### FLOPPY CONTROLLER BOARD

- +5 Volts only
- 4 single/double sided drives, 8 heads
- Single or double density under software control
- Dynamic allocation of files
- Buffered sector and block transfer modes for fast transfer

FP-950 controller board \$475

ADOS operating system on a 2532 EPROM \$100 Disk drive with power supply and case s/sided \$375 d/sided \$460

- 35,40 or 77 track side
- Independent motor ON/OFF control for 4 drives
- Powerful ADOS operating system have all necessary commands and file management. Full interface to AIM-65 basic, editor, assembler and monitor.

#### VIDEO CONTROLLER BOARD

- 80,64 or 40 character by 25 lines
- · 2K bytes of software on board fully interfaced to AIM-65 with full cursor control
- · Reverse video on character basis

CRT-80 video controller \$295

- · 2K refresh RAM not on address space of CPU with no wait states whem updating.
- Upper/lower case ASCII plus 128 semigraphic characters
- Combined and separated video outputs

#### **MEMORY BOARDS**

- +5 Volts only
- · Totally transparent refresh, no cycle stealing

MB-16K 16 K bytes board \$305

MB-32K 32 K bytes board \$375

MB-48K 48 K bytes board \$445

MB-64K 64 K bytes board \$515

- Memory selectable in 4k blocks by switches
- Bank selection

#### EXPANSION MOTHER BOARD

- Enabled in 4K increments by switches
- Straight extended from the expansion connector on the AIM-65
- Fully buffered
- 6 slots
- Supports DMA

EMB-6 expansion board \$195

OEM discounts . All boards fully assembled and tested

All boards are compatible with the EXORciser bus.

#### APPLIED BUSINESS COMPUTER CO.

707 S. State College., Suite G. Fullerton, Ca. 92631 Tel. (714) 871-1411

## Saving Data Matrices With Your SYM-1

George Wells

This article describes a machine-language program that enables BASIC data matrices to be saved on cassette tape and loaded back into the computer at a later time. There have already been several attempts to perform this function, but most of them suffer in one or more of the following ways:

- They will not allow the BASIC program to be modified.
- 2. They will not allow the BASIC data to be loaded into a different program.
- 3. They will not allow selected data to be saved on tape.
- 4. They will not allow string data to be saved on tape.
- 5. They are clumsy to use, requiring PEEKing and POKEing.

The program described here overcomes all of these problems. It will run only on a SYM-1 with the new MONITOR 1.1 ROM and will require extensive modification to enable it to run on other machines.

#### Functional Description Of Program

After the machine-language program is in memory and BASIC is running, all that is required to save a matrix is a statement of the form:

#### MATRIX (1,2,3) = USR (SAV,ID)

Where MATRIX (1,2,3) is any kind of matrix (numeric, integer or string) of any size with any number of dimensions, SAV is a previously defined variable pointing to the SAVE.MAT machinelanguage program and ID is a variable in the range of 0 to 127 which is the tape ID file number. This statement can be entered as a direct command after a program has been run or it can be used anywhere in a program, even in a loop. If you want to save the entire MATRIX, then use the same subscripts that were used to DIMension and the MATRIX. You can save a portion of the MATRIX by making the last subscript a smaller number than its DIMension. SAV and ID cannot be matrix variables.

To load a matrix back into the computer use a similar statement of the form:

#### MATRIX (1,2,3) = USR (LOA,ID)

Where LOA is a previously defined simple variable pointing to the LOAD.MAT machine-language program and the other variables are the same ones used to save the MATRIX.

If you have implemented a second cassette con-

trol for your SYM-1 (see MICRO 18:5) then the proper cassette will be turned on for a LOAd or a SAVe operation and you can write programs that in effect handle a very large data base by partitioning it into smaller chunks that are read in from one recorder, operated on and read out to the other recorder automatically.

#### Description Of Program Implementation

Step 1: Deposit and Verify the OBJECT LISTING. If you have only 4K of RAM, do this at 0EE6 and then change all of the 1F's to 0F's. This can be done easily with .M 1F,EE6-FFF (CR) followed by 11 sets of 0FG (no (CR)'s). Do another verify (.V EE6-FFF) which should give a checksum of 8747.

Step 2: Jump to BASIC (J 0) and use 7910 for the size or 3814 if you have 4K of RAM.

Step 3: Enter a program such as:

100 SAV = &"1F07" (or SAV = &"0F07" for 4K) 110 POKE 42544,10: REM LONG TAPE DELAY 120 FOR I = 0 TO 10 130 A%(I) = I 140 A(I) = SQR(I) 150 A\$(I) = CHR\$(I + 65) 160 NEXT I 150 A%(10) = USR(SAV,1) 180 A(10) = USR(SAV,2) 190 A\$(10) = USR(SAV,3)

Step 4: Rewind a tape and start it in record mode.

Step 5: RUN the program.

Step 6: When BASIC responds with OK, type NEW and enter a second program such as:

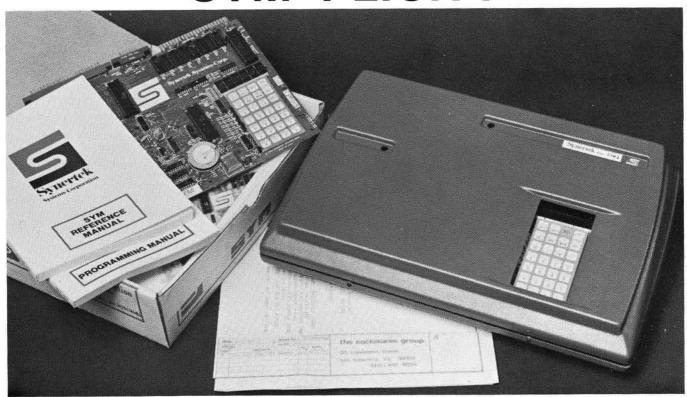
100 LOA = & "1EE6" (or LOA = & "0EE6" for 4K)
110 A%(10) = USR(LOA,1)
120 A(10) = USR(LOA,2)
130 A\$(10) = USR (LOA,3)
140 FOR I = 0 TO 10
150 PRINT A%(I), A(I), A\$(I)

Step 7: Rewind the tape and start it in play mode.

Step 8: RUN the program. After all the matrices are read in from tape they will be printed on the terminal.

Step 9: In case the computer has trouble reading a file, rewind the tape and restart it in play mode. If you want to abort the tape read process, hold the BREAK key on the terminal down until the tape stops. You can CONTinue from this point if you want to; however, the matrix that couldn't be read in will be cleared to zeroes or nulls.

## SYM-PLICITY



## ENGINEERED SPECIFICALLY FOR THE SYM-1 MICRO COMPUTER

- Easy Access for Adjustments
- Room for Expansion
- Protects Vital Components

#### **EASILY ASSEMBLED**

- Absolutely No Alteration of SYM-1 Required
- All Fasteners Provided
- Goes Together in Minutes

## MADE OF HIGH IMPACT STRENGTH THERMOFORMED PLASTIC

- Kydex 100\*
- Durable
- Molded-In Color
- Non-Conductive

#### **AVAILABLE FROM STOCK**

- Allow Two to Three Weeks for Processing and Delivery
- No COD's Please
- Dealer Inquiries Invited

#### ATTRACTIVE FUNCTIONAL PACKAGE

- Professional Appearance
- Popular "Data Blue" Color
- Improves Man/Machine Interface

TO ORDER: 1. Fill in this Coupon (Print or Type Please)
2. Attach Check or Money Order and Mail to:

> Please Ship Prepaid \_\_\_\_\_ SSE 1-1(s) @ \$36.75 each California Residents Please Pay \$39.14 (Includes Sales Tax)

## enclosures group

771 bush street san francisco, california 94108

COPY OF TAPE ID

.DE \$6F

0010 ID

#### Description Of Program Operation

The program stores two copies of each file on tape to provide an automatic back-up in case of error during loading. Between files, the tape delay is set to its minimum possible value (about 1.5 seconds) and set back to its default value (about 6 seconds) at the end of the routine. You can change these values if you have special requirements. Also, you can set the tape delay to a larger value at the beginning of tape operations to automatically move the tape off its leader, as in the first sample program above at line 110.

For numeric and integer matrices, the elements themselves are stored directly on tape with no manipulation since they are already in contiguous order. The start and stop addresses are determined from "foot-prints" on page zero left over from the normal matrix interpretation done by BASIC.

For string matrices the procedure is considerably more complex. About one half of the total code is involved in the special requirements of strings since they are not stored together in one place. The best we can do is rearrange things until all the string information is contained in two separate files which can be stored on tape. The first of these files consists of three bytes per string. The first byte is the length of the string and the last two are a pointer or address to where the ASCII characters making up the string are stored. This first file is already in contiguous order but before it can be used the second file must be created since the first file contains pointers to the second file. The second file is created by going through all the string pointers (in reverse order) and copying each string into unused memory space using two of the BASIC interpreter routines which leave the strings themselves in one continuous block. When the first file is stored it is given an ID greater than 127 (most significant bit is set) so the load routine can distinguish it from the second file.

The routines determine when a string matrix is being operated on by pulling six bytes off the stack and branching on the condition of a zero which indicates a non-string matrix. These six bytes plus one more are

>ASSEMBLY LISTING:

	0070 CUR.STRING 0080 NEW.STR.PN 0090 NEW.STRING 0100 XFR.STRING 0110 ACCESS 0120 INJISV 0130 F1 0140 DIG	.DE \$70 C .DE \$99 F .DE \$6D C .DE \$78 P .DE \$88 P .DE \$82A9 P .DE \$8386 S .DE \$8386 S .DE \$8392 C .DE \$8392 C .DE \$8440 P .DE \$8444 P .DE	COPY OF TAPE ID  OINTER TO FIRST ELEMENT OF MATRIX  COPY OF *MAT.START  POINTER TO MATRIX CURRENT ELEMENT  COPY OF END OF MATRIX FOR ABORT  UNDER OF BYTES PER ELEMENT  CURRENT STRING TO BE TRANSFERRED  COINTER TO NEW STRING  CET LOCATION OF STRING OF LENGTH=A  RANSFER STRING TO NEW LOCATION  CYSTEM MONITOR RAM UNPROTECT  CHARRY SET MEANS BREAK  IDDUE OF MONITOR FILL ROUTINE  CIRST DIGIT OF DISPLAY  CAPE START ADDRESS  CAPE STOP ADDRESS  CAPE STOP ADDRESS  CAPE DELAY LOCATION  CAPE DELAY DEFAULT VALUE  CASSIC JUMP VECTOR TO SAVE TAPE  CAPESIC JUMP VECTOR TO LOAD TAPE
1EE6- 20 2E 1F	0250 LOAD.MAT	JSR INIT.PARMS	INITIALIZE TAPE PARAMETERS FOR FIRST FILE
1EE9- 68 1EEA- 68 1EEB- 68 1EEC- 68 1EEC- 68	0300	PLA PLA PLA PLA	THROW AWAY 7 STACK BYTES 6 NOW, 1 LATER
1EEF- F0 0B 1EF1- 20 C9 1F	0330	JSR LOADT.HS	GET STRING POINTER FILE
1EF4- 20 5F 1F 1EF7- F0 0C 1EF9- 20 9E 1F 1EFC- A5 6F	0350 0360 0370 0380 LOAD.MAT6	JSR ORD.STRING BEQ LOAD.MAT7 JSR STR.PARMS LDA +ID	BRANCH IF NOT STRING MATRIX GET STRING POINTER FILE (ID MUST BE > 127) RESERVE STRING FREE SPACE BRANCH IF ALL STRINGS NULL SET UP STRING PARAMETERS ID MUST BE < 128
1EFE- 29 7F 1F00- 35 6F	0390 0400	STA AID	
1F02- 20 C9 1F 1F05- 68 1F06- 60	0410 0420 LOAD.MAT7 0430 0440	JSR LOADT.HS PLA RTS	GET LAST FILE THROW AWAY LAST STACK BYTE RETURN TO BASIC
1F07- 20 2E 1F 1F0A- 68 1F0B- 68	0450 SAVE.MAT 0460 0470	JSR INIT.PARMS PLA PLA	INITIALIZE TAPE PARAMETERS FOR FIRST FILE
1F0C- 68 1F0D- 68 1F0E- 68 1F0E- 68	0510	PLA PLA PLA PLA	THROW AWAY 7 STACK BYTES 6 NOW, 1 LATER
	0560		BRANCH IF NOT STRING MATRIX PUT MATRIX STRINGS IN ORDER BRANCH IF ALL STRINGS NULL SAVE 2 COPIES OF POINTERS WITH ID > 127
1F1A- 20 9E 1F 1F1D- A5 6F 1F1F- 29 7F		AND #\$7F	SET UP STRING PARAMETERS MAKE ID < 128
1F21- 8D 4E A6 1F24- 20 BC 1F 1F27- A9 04 1F29- 8D 30 A6	0600 0610 SAVE.MAT7 0620 0630	STA P1 JSR SAVET.2.HS LDA #TAPE.DELA STA TAPDEL	S SAVE 2 COPIES OF LAST FILE RESTORE TAPE DELAY DEFAULT
1F2C- 68 1F2D- 60	0640 0650 0660	PLA RTS	THROW AWAY LAST STACK BYTE
1F2E- 20 86 8B 1F31- 98 1F32- 09 80 1F34- 8D 4E A6	0680 0690	: JSR ACCESS TYA ORA ≎\$80 STA P1	PASS ID TO PARM 1 BUT MAKE ID > 127
1F37- 85 6F 1F39- A5 A8	0710 0720	STA ◆ID LDA ◆MAT.START	ALSO SAVE COPY FOR STRINGS PASS MATRIX START TO PARM 2
1F3B- 8D 4C A6 1F3E- 85 70 1F40- A5 A9	0740	STA P₽ STA ◆MAT.START LDA ◆MAT.START	TC ALSO SAVE COPY TO ORDER
1F42- 8D 4D 86 1F45- 85 71	0750 0760 0770	STA P2+1 STA +MAT.STAR	
1F47- A5 99 1F49- 85 BF	0780 0790	LDA •MAT.CUR.E STA •CUR.STRIN	EL CALCULATE PARM 3
1F4B- 18 1F4C- 65 78 1F4E- 8D 4A A6		ADC ◆EL.SIZE STA P3	CURRENT ELEMENT
1F51- 85 6D 1F53- A5 9A	0830 0840	STA +MAT.ENDC	EL+1
1F55- 85 C0 1F57- 69 00	0350 0360	STA +CUR.STRIN	9G+1 PROPAGATE CARRY
1F59- 8D 4B A6 1F5C- 85 6E	0870 0880	STA P3+1 STA +MAT.ENDC+	+1
1F5E- 60	0890 0900	RTS	
1F5F- A9 00 1F61- 85 9A	0910 ORD.STRING	LDA ⇔0 STA ◆MAT.CUR.E	CLEAR NON-NULL STRING FLAG
1F63- A0 00 1F65- B1 BF	0930 ORD.STR.1	LDY #0	NG),Y LENGTH OF CURRENT STRING
AMM 15057 R/S 1553	THE REST	THE STATE OF STATE	- t

normally used to pass pertinent information to the calling routine. However, as they are used here, we don't want the calling routine to store the returned value in the specified matrix, so we simply discard the seven stack bytes. In fact, under normal conditions, it is not possible to specify a string variable in a USR statement, but by pulling seven bytes off the stack, we avoid the type mismatch (TM) error test (which fortunately is done after returning from USR) and return one level deeper which causes the BASIC interpreter to go on to the next statement.

If an attempt is made to store a string matrix that consists entirely of null strings, then only the first file is stored since there will be nothing in the second file. Special tests are made in both the save and load routines to handle this case. Also, it is necessary to use the end of the last non-null string as the end of the second file since to use the pointer of a null string would result in a meaningless tape stop address. Special tests are used to perform this function.

It is a good idea to eliminate DATA statements from a program after they are used to initialize a matrix that is stored on tape since they will only take up memory in future runs. If during the ordering of strings the memory is actually used up, a OM (out of memory) error will occur.

No record is kept on the tape of the name of the matrix or its size and no tests are performed to verify these things. However, if the file does not have the correct number of bytes in it, it will fail the normal tape error tests. The intention is to provide a means for a program or operator to save and retrieve data conveniently, but the task of remembering the size of the matrix or portion of matrix remains with the program or operator. Unlike the usual BASIC command for LOADing programs, if you don't know how big the matrix is that is on a tape, it can be very difficult to load it, so be organized in your use of these routines and they will serve you well.

	1F67-	FO	10		0950		BEQ	DRD.STR.3	BRANCH IF LENGTH = 0 (NULL)
	1F69-				0960		LDX	◆MAT.CUR.EL+1	
	1F6B-	DO	08		0970		BNE	ORD.STR.2	BRANCH IF NON-NULL STRING
					0980				ALREADY FOUND
	1F6D-				0990			◆CUR.STRING	COPY POINTER TO LAST NON-
	1F6F-				1000			◆MAT.CUR.EL	NULL STRING
	1F71-				1010			+CUR.STRING+1	
	1F73-				1020			+MAT.CUR.EL+1	
	1F75-					DRD.STR.2	JZK	NEW.STRING	GET NEW LOCATION FOR STRING
	1F78-		2F	D4	1040			XFR.STRING	TRANSFER TO NEW LOCATION
	1F7B-				1050		INY	ANELL STD DN	Y = Y + 1 = 1
	1F7C-				1060			◆NEW.STR.PN (CUR.STRING),Y	COPY NEW STRING POINTER
	1F7E-				1070			◆NEW.STR.PN+1	
	1F80-	10.000	84		1080		INY	THEW. STR. PHYL	
	1F82-		ne		1090			(CUR.STRING),Y	
	1F85-					non ore o		◆CUR.STRING	GET NEXT STRING POINTER
	1F87-		DF		1120	DKD.SIK.S	SEC	POOR STRING	(WORKING FROM LAST TO
	1F88-		70		1130			◆EL.SIZE	FIRST SD SUBTRACT)
	1F8A-				1140			+CUR.STRING	
	1F8C-				1150			◆CUR.STRING+1	
	1F8E-				1160			DRD.STR.4	
	1F90-				1170		DEX		PROPAGATE BORROW
	1F91-		CO			DRD.STR.4		◆CUR.STRING+1	
	1F93-	E4	71		1190		CPX	◆MAT.STARTC+1	TEST FOR ALL STRINGS DONE
	1F95-	DO	CC		1200		BNE	ORD.STR.1	
	1F97-	C5	70		1210		CMP	◆MAT.STARTC	
	1F99-	BO	C8		1550		BCS	DRD.STR.1	
	1F9B-	A5	98		1230			◆MAT.CUR.EL+1	SET Z IF ALL STRINGS HULL
	1F9D-	60			1240		RTS		
					1250				
	1F9E-					STR.PARMS			START OF STRINGS TO PARM 2
	1FA0-			A6			STA		
	1FA3-				1280			+NEW.STR.PN+1	
	1FA5-				1290			P2+1	
	1FA8-	HU	00		1300		LDY	CMOT CUD FLA V	END DE STRINGS TO DOOM S
	1FHH-	BI	99		1310		CDH	(MAT.CUR.EL),Y	END OF STRINGS TO PARM 3
	1FAC-	18			1320		TNY		
	1505-	71	99		1330		ADC	<pre> (MAT.CUR.EL),Y  (MAT.CUR.EL),Y  P3  (MAT.CUR.EL),Y</pre>	ADD LENGTH OF LAST NON-NULL
	1FPO-	OD	10	94	1350		STA	P3	STRING TO ITS POINTER TO
	1FB0-	Con	411	по	1360		TNY		END OF STRINGS
	1FB4-	B1	99		1370		I De	(MAT.CUR.EL),Y	END DE STRINGS
	1FB6-				1380		ADC		
Ĺ	1FB8-			86	1390			P3+1	
	1FBB-				1400		RTS		
	5				1410				
	1FBC-	20	C4	1F	1420	SAVET.2.HS	JSR	SAVET.HS	SAVE 2 COPIES IN HI-SPEED
	1FBF-				1430		LDA		MODE WITH MINIMUM DELAY
	1FC1-			A6	1440			TAPDEL	BETWEEN THEM
	1FC4-					SAVET.HS		<b>\$</b> 80	
	1FC6-	4C	C6	0.0	1460		JMP	J.SAVET	JUMP THROUGH BASIC VECTOR
		~~		~~	1470	F BODT - US	100	THUTOU	TEST ERR PRESS
	1FC9-			83	1490	LOADT.HS		INJISV ABORT	TEST FOR BREAK
	1FCE-				1500				GET ANY FILE FROM TAPE
	1FD0-			86			STA	The Court of the C	Je. Ant Free Fren Ince
	1FD3-				1520			<b>\$</b> \$80	
ē	1FD5-								JUMP THROUGH BASIC VECTOR
	1FD8-				1540		BCS	LOADT.HS	REPEAT IF BAD LOAD
	1FDA-			A4	1550				GET ID
	1FDD-				1560		CMP		
	1FDF-				1570		BNE	LOADT.HS	REPEAT IF WRONG ID
	1FE1-	60			1580		RTS		
					1590				
	1FE2-	68			1600	ABORT	PLA		DISCARD EXTRA STACK BYTES
	1FE3-				1610		PLA		
		00			1620		PLA		
	1FE4-								CLEAR ABORTED MATRIX
Ç.	1FE5-	89			1630		LDA		
	1FE5- 1FE7-	A9 A6	70		1640		LDX	◆MAT.STARTC	SET UP FOR MONITOR FILL
	1FE5- 1FE7- 1FE9-	A9 A6 A4	70 71		1640 1650		LDX	◆MAT.STARTC ◆MAT.STARTC+1	
	1FE5- 1FE7- 1FE9- 1FEB-	A9 A6 A4 86	70 71 FE		1640 1650 1660		LDX LDY STX	◆MAT.STARTC ◆MAT.STARTC+1 ◆\$FE	
	1FE5- 1FE7- 1FE9- 1FEB- 1FED-	A9 A6 A4 86 84	70 71 FE FF		1640 1650 1660 1670		LDX LDY STX STY	◆MAT.STARTC ◆MAT.STARTC+1 ◆\$FE ◆\$FF	
	1FE5- 1FE7- 1FE9- 1FEB- 1FED- 1FEF-	A9 A6 A4 86 84 A4	70 71 FE FF 6E		1640 1650 1660 1670 1680		LDX LDY STX STY LDY	<pre>MAT.STARTC  MAT.STARTC+1  SFE  SFF  MAT.ENDC+1</pre>	
	1FE5- 1FE7- 1FE9- 1FEB- 1FED- 1FEF- 1FF1-	A9 A6 A4 86 84 A4 A6	70 71 FE FF 6E 6D		1640 1650 1660 1670 1680 1690		LDX LDY STX STY LDY LDX	•MAT.STARTC •MAT.STARTC+1 •%FE •%FF •MAT.ENDC+1 •MAT.ENDC	
	1FE5- 1FE7- 1FE9- 1FEB- 1FED- 1FEF- 1FF1- 1FF3-	A9 A6 A4 86 84 A4 A6 D0	70 71 FE FF 6E 6D		1640 1650 1660 1670 1680 1690 1700		LDX LDY STX STY LDY LDX BNE	•MAT.STARTC •MAT.STARTC+1 •\$FE •\$FF •MAT.ENDC+1 •MAT.ENDC ABORT.4	SET UP FOR MONITOR FILL
	1FE5- 1FE7- 1FE9- 1FEB- 1FED- 1FEF- 1FF1- 1FF3- 1FF5-	A9 A6 A4 86 84 A4 A6 D0 88	70 71 FE FF 6E 6D		1640 1650 1660 1670 1680 1690 1700 1710		LDX LDY STX STY LDY LDX BNE DEY	•MAT.STARTC •MAT.STARTC+1 •\$FE •\$FF •MAT.ENDC+1 •MAT.ENDC ABORT.4	
	1FE5- 1FE7- 1FE8- 1FED- 1FEF- 1FF1- 1FF3- 1FF5- 1FF6-	A9 A6 A4 86 84 A6 D0 88 CA	70 71 FE FF 6E 6D 01		1640 1650 1660 1670 1680 1690 1700 1710		LDX STX STY LDY LDX BME DEY DEX	+MAT.STARTC +MAT.STARTC+1 +SFE +SFF +MAT.ENDC+1 +MAT.ENDC ABORT.4	SET UP FOR MONITOR FILL
	1FE5- 1FE7- 1FE9- 1FEB- 1FED- 1FF1- 1FF3- 1FF5- 1FF6- 1FF7-	A9 A6 A4 86 84 A6 B0 88 CA	70 71 FE 6E 6D 01	<b>A</b> 6	1640 1650 1660 1670 1680 1690 1700 1710 1720		LDX LDY STX STY LDY LDX BNE DEY DEX STX	+MAT.STARTC +MAT.STARTC+1 +&FE +&FF +MAT.ENDC+1 +MAT.ENDC ABORT.4	SET UP FOR MONITOR FILL
	1FE5- 1FE7- 1FE9- 1FEB- 1FED- 1FF1- 1FF3- 1FF5- 1FF6- 1FF7- 1FFA-	A9 A6 A4 86 84 A6 D0 88 CA 8E 8C	70 71 FE 6E 6D 01 4A 4B	A6 A6	1640 1650 1660 1670 1680 1690 1700 1710 1720 1730 1740		LDX LDY STX STY LDY LDX BME DEY DEX STX STY	+MAT.STARTC +MAT.STARTC+1 +SFE +SFF +MAT.ENDC+1 +MAT.ENDC ABORT.4 P3 P3+1	SET UP FOR MONITOR FILL  SUBTRACT ONE FROM END
	1FE5- 1FE7- 1FE9- 1FEB- 1FED- 1FF1- 1FF3- 1FF5- 1FF6- 1FF7-	A9 A6 A4 86 84 A6 D0 88 CA 8E 8C	70 71 FE 6E 6D 01 4A 4B	A6 A6	1640 1650 1660 1670 1680 1690 1700 1710 1720 1730 1740		LDX LDY STX STY LDY LDX BNE DEY DEX STX	+MAT.STARTC +MAT.STARTC+1 +SFE +SFF +MAT.ENDC+1 +MAT.ENDC ABORT.4 P3 P3+1	SET UP FOR MONITOR FILL

## Part 1 of a series: OSI ROMS

T. R. Berger

There seems to be some curiosity about OSI's non-BASIC ROMs, i.e. ones above address \$F800. The schematic for the C1, 2, 4, and 8 shows a 2K ROM (type 2316B). Disassembly shows that the C1 has the full 8 pages of this ROM addressed in memory locations \$F800 to \$FF00, but the C2, 4, and 8 have only 3 pages of this 8 page ROM appearing in memory. Actually, there is only one 2K ROM used in all these machines! (The old C2's without polled keyboard and the C3 with serial monitor or hard disk are exceptions which we will ignore.)

The C2, 4, and 8 have special address selecting circuitry which allows the computer to choose and address any 3 of the 8 pages in this 2K ROM. The C1 does not contain this special circuitry (presumably to cut costs) so that all 8 pages of the ROM appear in memory whether or not they are needed. The C1 uses 4 of the 8 pages and the remaining 4 pages fall where they will, misaddressed and unrunable. Since the C1 is the only machine with all 8 pages, let us use C1 addresses to describe the various pages of this ROM.

The page in which a segment of code appears in the C1 is not necessarily the page in which the code is written to run. For example, Cold Start for ROM BASIC C2, 4, and 8 computers was written to run in page \$FF but appears in page \$FB in the C1. In particular, in the C1 at \$FB43 we see JSR \$FFB8. The requested subroutine now appears at address \$FBB8 in the C1 and \$FFB8 is actually the third byte of a jump instruction. If the computer is asked to run this code, this subroutine jump will send the computer to limbo. Thus the code (with minor exceptions of no importance) in page \$FB of the C1 will not run.

Table 1 gives a summary of the various functions of this ROM. The first column gives the C1 page number, the second column gives the model numbers of Challengers which use the given page of code (e.g. 4 means C4); the third column gives the type of machine (i.e. ROM BASIC or Disk); the fourth column gives the function of the page; and finally, the fifth column tells in which page the code was written to run.

C1 owners with a disassembler may read the code which all of us run. The rest of us will have to make do with the pages we actually use. However, not much is missed since the code is highly redundant. Commercial computer users know that the most costly facet of computing is software development. OSI can sell its computers at low cost because of a policy minimizing software development costs. That is, if a program is written for one machine, and by

patching existing code it will run on another (even though at less than peak efficiency) then, by all means, patch. Thus the C1 code in these ROMs is just patched versions of the code written for the C2, 4, and 8. If this ROM were rewritten carefully, it would easily fit into 1K and run on all machines. But the larger ROMs come much more cheaply than rewriting the code. MORAL: Hardware is cheap, software is expensive. Businessmen know this; we do too when we yell 'software ripoff!'

Since C1 run pages differ only in patches and relocation (with precious little relocation) from C2, 4, and 8 run pages, it is necessary to only understand about half of this ROM in order to understand it all. The fundamental pages are listed in Table 2. When the code was patched to run on the C1, every effort was made not to move addresses. For example, where the machine monitor for the C2, 4, and 8 resets a P1A not available on the C1, (C1 addresses \$FA04 to \$FA0B), the corresponding code for the C1 is filled with NOP instructions (C1 addresses \$FE04 to \$FE0B).

I am writing a series of articles on the OS65D operating system. The first article, on the Kernel, should appear in the next issue. At least one later article in this series will be devoted to this ROM. In particular, much more detail on these ROMs will appear in the near future. If you have urgent questions, you may send a stamped self-addressed envelope to me at:

Tom Berger 10670 Hollywood Blvd. Coon Rapids, MN. 55433

TABLE 1				
C1P PAGE	MACHINE	TYPE	FUNCTION	RUN PAGE
\$F8	2,4,8	DISK	BOOT	\$FF
\$F9	2,4,8	ALL	KEYBOARD	\$FD
\$FA	2,4,8	ALL	MONITOR	\$FE
\$FB	2,4,8	ROM BASIC	BOOT	\$FF
\$FC	1	DISK	BOOT	\$FC
\$FD	1	ALL	KEYBOARD	\$FD
\$FE	1	ALL	MONITOR	\$FE
\$FF	1	ALL	BOOT	\$FF

## ALL ABOUT OSI MICROSOFT BASIC-IN-ROM, VERSION 1.0 REV 3.2

by Edward H. Carlson

Published by the author 3872 Raleigh Drive Okemos, MI, 48864 8½ x 11 inches Soft-cover, 6O Pages, \$8.95

Review by Charles L. Stanford

This book would almost certainly have saved me from many very frustrating hours of pouring through OSI's so-called "Manuals" and several of the general texts on BASIC during the first months I owned my C1P. Would you believe, I discovered how to use the immediate mode by accident, in about the fifth week? Mr. Carlson covers the subject very nicely on the first page of his new book.

Granted, BASIC is BASIC, to a very large degree. It's not too hard to convert from one computer's BASIC to another's. Most commands and functions act alike. But there are significant differences in some areas; I can never remember the exact result of some of the functions I seldom use, such as TAB and INPUT. So every encounter with those commands in a published program requires some searching in the files. This reference book ends that.

Mr. Carlson states in the introduction that he is presenting OSI BASIC on two levels; pure BASIC, and then the underlying principles of program code storage, pointers, flags, and the way programs really work. He succeeds admirably in the first, with only minor exceptions. Each of the commands, statements, functions, and operators is listed and discussed in detail. Many examples and suggestions are included, and useful combinations of functions are presented. In particular, I learned some things about the USR function I could only guess at before (and I use it heavily). A very few of the functions covered could have stood a heavier treatment. WAIT I.J.K and the Boolean Operators AND, OR, and NOT are, as is usual, glossed over, apparently under the theory that everyone understands Boolean Algebra. It is very elementary, but many hobbyists haven't yet seen its usefulness, and may never until more of its advantages are more thoroughly pointed

out and explored. Be assured, though, that these are minor faults - the coverage of BASIC is very thorough. This manual, together with a more generalized text (such as Basic BASIC) should meet any programmer's needs.

Mr. Carlson's treatment of his second task is not quite so successful, although still very thought-provoking and useful. He has caused some considerable loss of sleep, while I explore the machine codes his lists and tables point out. There is an extremely well annotated memory map for pages \$00 through \$03, as well as a listing of the Monitor ROM from \$FE00 to \$FFFF. The ROM listing is for the C2-4P, but differences in the C1P ROM are called out in a separate list. I think most OSI owners have figured out by now that the BASIC ROMs are identical for all models, with only the Monitor ROMs being different.

Other useful discussions are presented on the format and programming of both BASIC and Machine Language tapes, floating point numbers, and the way the program stores variables. Less successful sections cover the source code and two's complement binary numbers. The only section that fails badly, however, is the one on OSI's Big Bug. I refer, of course, to the String Array Garbage Collection glitch. The author presents what might appear to be a really simple solution. It does, in fact, work. But it's virtually impossible to overlay on an existing program which uses a lot of concatenated string arrays. There are more effective solutions to this bug.

All in all, I think that any of several sections of this very well presented manual are worth the purchase price. I recommend it to the hobbyist and to the serious programmer alike.

# Fast Graphics On The OSI C1P

Charles L. Stanford

I am sure that almost without exception, OSI C1P and Superboard II owners get a major part of their computer fun from games. The relative ease of graphics programming using the game symbols in the Character Generator ROM allows even the novice BASIC programmer a lot of freedom for creating exciting and fastmoving figures. However, even OSI's very fast BASIC still leaves a lot to be desired when more than a few dozen screen locations are changed, resulting in distracting image changes and in slow execution of commands.

This article will present a "cookbook" version of a machine language graphics subroutine. The BASIC user with little or no background in Machine or Assembly language programming will be able to use the material presented here to "plug in" his own graphics. The more advanced programmer will be able to adapt the concepts shown to complicated, interactive graphics games and simulations.

#### The use of graphics in games

While many exciting and worthwhile games are played without graphics (such as most versions of Starwars, Star Trek, Quest, etc.), most family fun games revolve around the manipulation of graphics figures or objects on the screen. Six Gun Shootout, Tank, Lunar Lander, and many others are "made" by their graphics interactions. But a game like Six Gun written solely in BASIC is slowed down so badly by the time required to POKE two gunfighters and a few cacti that it looses a lot of its **Oomph!** Even a near-instantaneous screen routine (instead of scrolling) only helps a little when 50 or 100 or more POKE's are needed every time a move is made.

The method presented in this article does have a few limitations, mainly in the opportunity for typing errors when entering the many DATA statements, and in the need to carefully plan and structure each and every character before starting to enter the program. But the results are really worth it. Every program I've written since devising this method has had to be slowed down with time delay loops, which is sure better than the alternative.

#### The USR Function

The OSI Graphics Reference Manual and the BASIC in ROM Manual are ridiculously brief in describing the use of the USR function. On the other hand, there isn't that much knowledge needed for an elementary application such as this one. In general, you will need to be capable of converting Hex numbers to Decimal quickly and accurately; the only other require-

ment is to be able to write a fairly structured BASIC program.

When the USR function is called by a line such as 10 X = USR(X), the program goes to the machine language program subroutine pointed to by the data at memory locations \$000A and \$000B (Decimal #11 and #12). The 6502 processor needs a 16 bit address to jump to a subroutine. But each memory location only has 8 bits. So the processor reads the eight lower (right-most) bits of the address from the lower of two adjacent memory addresses, and the eight higher (left-most) bits from the higher. Thus, a machine language routine at address \$0222 would be called if memory locations \$000A and \$000B held \$22 and \$02 respectively. These numbers would be inserted in these two RAM locations by a line in BASIC such as 20 POKE 11,34: POKE 12,2. Note that the Hex numbers have to be converted to their Decimal equivalents for BASIC. As you can see, many machine programs starting at as many different memory locations could be called, merely by changing the data at \$000A and \$000B before calling the USR function. I'll describe how to write and insert the actual machine language subroutines a bit later in this article.

After a machine language subroutine is called, it acts very similarly to a BASIC program, in that each instruction is executed in order until a RETURN is encountered. It then returns to the next instruction after the JUMP. The RETURN in machine language is the RTS instruction, which is Hex \$60 (or Dec #96).

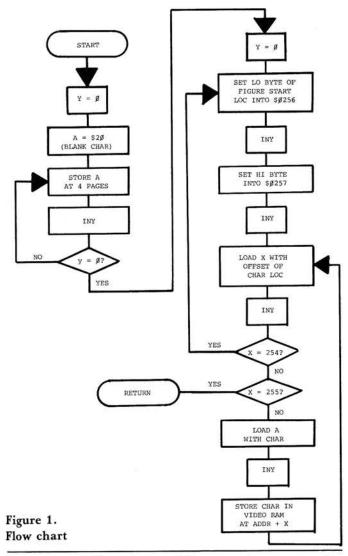
The advantage of all this is, of course, based in the fact that machine language is somewhere around 1000 times faster than BASIC for most equivalent functions. This feature is particularly useful for graphics programming.

#### Machine language programming

Writing programs in machine language, especially without the use of an Assembler, is a bit tedious. But the end result is often worth the effort. In this case, you, the reader, will use the program itself exactly as presented here, only changing a table which will hold whichever graphics figures needed for your particular game.

The action of the subroutine is quite simple. After a Screen Clear (note that the first eight lines of Listing 1 are as shown in my previous article in Compute II Number 1), a series of graphics characters and their locations relative to a fixed point are read from memory and written to the TV screen.

The routine makes use of one of the 6502 processor's more efficient addressing modes, Zero Page. Line 023A uses the instruction LDA-0,Y, which loads the accumulator with the data residing at a memory location equal to the value of the address pointed to by FE (lo byte) and FF (hi byte) plus the contents of the Y register. These two memory locations at the top of Zero page were chosen as they are easy to



remember, and are not used for any other purpose by BASIC or the Monitor. Since the Y register is an eight-bit register, only screen locations between the base address and the base address plus 255 can be called.

Looking at the flow chart (Figure 1), you can see that the first data loaded is the lo byte, then the hi byte, of the screen location. This information is in the table for this particular game, and is deposited within the program to give a start location on the screen for the first graphics figure. Next, the offset of the first character is loaded into the X register, and a check is made to see if the figure is ended. I have selected \$FE (254) as a signal that part of the figure is completed, and \$FF (255) for the end of the routine. If this data is neither, a graphics symbol will be loaded into the accumulator. This symbol is then deposited into the video refresh memory at the location previously loaded plus the offset in the X register.

This may all sound a bit complicated, but that doesn't make any difference to you, the programmer. The program will take care of itself if the proper data is presented from the symbol table in the correct sequence.

#### Developing the screen image

The screen image is developed by following five easy steps, starting with a copy of the C1P Screen Grid. Being a railroad fan, I chose to enact the "Great Train Collision" as a demonstration program. As you can see from Figure 2a, the OSI graphics symbols allow for a very reasonable steam locomotive with tender. After you have drawn whatever figures you need for your game to your satisfaction, enter the screen offsets of all locations, starting at a fixed point at the upper left corner of each figure, as shown in Figure 2b. Finally, write in the character generator code as shown in Figure 2c. The last step is to enter the data into a table as shown in Listing 2. Note that each figure is preceded by a screen address (lo byte first), and ends in either FE or FF. The last figure in the table must be FF (255) which causes the subroutine to return to BASIC.

#### Converting the Machine Language to BASIC

There are several methods of entering machine or assembly language programs through the use of BASIC programs, including direct entry through the monitor. There are also several ways to save combination BASIC-machine language programs to tape (see Daniel Schwartz' article in Compute II issue 1). However, I prefer the somewhat tedious but easy to debug and modify DATA-POKE method. This is hard to enter error-free, and causes a significant delay on program initiation, but it has the advantage of being more readily understandable, and allows your routines to be changed easily.

You can see that lines 100 through 145 in Listing 3 enter the machine language subroutine into memory, while lines 148 through 199 are the table of offsets and characters for the figures. This is to allow the use of this sequence with other graphics figures of your own choosing. Note also that the subroutine is inserted into RAM at \$0222 (#546) in page 2. The page 2 memory from \$0222 to \$02FA is not used by BASIC, and is thus a good free place for this use. However, make sure your figures don't extend above \$02FA. If so, you'll have to locate the table in the top of RAM, necessitating memory protection at Cold Start. The subroutine can still reside at \$0222.

#### Animating the Figures

Once the graphics subroutine and the figure table are in RAM, the animation routines can be written in BASIC. The addresses needed to animate the demonstration figures are as follows:

HEX	DEC	DESCRIPTION
000A	11	Pointer to the starting address
000B	12	of the USR subroutine.
OOFE	254	Pointer to the starting address of
OOFF	255	the first graphics figure to be called.
0222	546	Actual starting address of the USR subroutine, including screen clear.
0238	568	Actual starting address of the USR subroutine without screen clear.
0260	608	Actual starting address of the first

\$Ø222	ΑØ	ØØ		546	16Ø	Ø		LDY-IMM	\$ØØ
Ø224	A9	2Ø		548	169	32		LDA-IMM	\$2Ø
Ø226	99	ØØ	D3	55Ø	153	Ø	211	STA-Y	
Ø229	99	ØØ	D2	553	153	Ø	21Ø	STA-Y	
Ø22C	99	ØØ	D1	556	153	Ø	2Ø9	STA-Y	
Ø22F	99	ØØ	DØ	559	153	Ø	2Ø8	STA-Y	
0232	C8			562	2ØØ			INY	
Ø233	DØ	F 1		563	2Ø8	241		BNE	\$Ø226
Ø235	EA	EA	EA	565	234	234	234	NOP NOP NOP	
Ø238	ΑØ	ØØ		568	16Ø	Ø		LDY-IMM	\$ØØ
Ø23A	B 1	FE		57Ø	177	254		LDA-Ø,Y	LDA Lo Byte Scr Loc
Ø23C	8D	56	Ø2	572	141	86	2	STA-ABS	
Ø23F	C8			575	2ØØ			INY	
Ø24Ø	B 1	FE		576	177	254		LDA-Ø,Y	LDA Hi Byte Scr Loc
Ø242	<b>8</b> D	57	Ø2	578	141	87	2	STA-ABS	
Ø245	C8			581	2ØØ			INY	
Ø246	B 1	FE		582	177	254		LDA-Ø,Y	LDA w/ Char Offset
Ø248	AA			584	17Ø			TAX	A to X Register
Ø249	C8			585	2ØØ			INY	
Ø24A	ΕØ	FE		586	224	254		CPX-IMM	X=254?End Figure
Ø24C	FØ	EC		588	24Ø	236		BEQ	Branch to Ø23A
<b>Ø24</b> E	ΕØ	FF		59Ø	224	255		CPX-IMM	X=255?End Routine
Ø25Ø	FØ	Ø8		592	24Ø	8		BEQ	Branch to Ø25A
Ø252	B1	FE		594	177	254		LDA-Ø,Y	Load Character
Ø254	C8			596	2ØØ			INY	
Ø255	<b>9</b> D	44	D1	597	157	68	2Ø9	STA-ABS,X	Char. to Screen
Ø258	DØ	EC		6ØØ	2Ø8	236		BNE	Get another Character
Ø25A	6Ø	EA	EA	6Ø2	96	234	234	RTS NOP NOP	End Routine, Return
<b>Ø25</b> D	EA	EA	EA	6Ø5	234	234	234	NOP NOP NOP	
Listing 1	. Mac	chine	e Language	Subrouti	ne				

0261 609 graphics figure. These locations hold the video RAM reference address,

Lo byte first, for the figure.

O29D 669 Actual starting address of the second
O29E 670 graphics figure. Also hold the

029E 670 graphics figure. Also hold the video RAM starting address for this figure.

It is important to remember that the last two locations will vary depending on the location in RAM chosen to store the table, and according to the length of the figures in the table. The first four sets of addresses will remain the same for all programs.

In the demonstration program, memory location #12 always holds a #2, but the data in location #11 is changed back and forth between #34 and #56;

this alternately inserts and omits the screen clear routine at the beginning of the machine language subroutine. If your program only has one figure, or if you end all figures but the last with #254, location #11 would stay at #34. Either method works equally well; chose the alternative which provides easiest animation in BASIC.

Note that if each figure ends with a #254, the data at memory location #254 will not change. But ending the first or any intermediate figure with #255 terminates the subroutine (see flow chart), and the only way to reach the next or subsequent figures is to change the pointer at #254 and #255.

As previously mentioned, the first two numbers in the table at the beginning of each figure are the video RAM address of the upper left hand corner of the figure. Since the video RAM of the C1P contains four pages of 256 bytes each, starting at \$D000, the first number in the table at the start of each figure can vary from 0 to 253 (remember, 254 and 255 are signals), and the second can be \$D0 through \$D3 (#208 through #211). By POKEing different numbers into these locations, the figures can be made to move around the screen. It's better to use the actual first location of each figure in the original DATA statements, to avoid a jerk at the start of the program. After that, any desired location can be POKE'd into these addresses.

In lines 25 and 35 of Listing 2, variables A and B are established as the low bytes of the screen locations for the two figures. Then, in the subroutine starting at line 50, they are POKE'd to 608 and 669 respectively, and then incremented and decremented and POKE'd again to move the characters across the screen toward each other. To make the

demonstration program more realistic, the engines are moved across the screen on different lines, and then reappear on a collision course. This is done by line 35, which changes A and B and also changes the hi byte of the right locomotive to #209 from 210, moving it higher on the screen. Variable C determines how far across the screen each figure will move.

Finally, the routines at lines 200 to 399 give a rough representation of an explosion at the point of collision. I leave to the reader the exercise of adding this to the machine language table. It's not that hard!

#### Summary

In order, the steps for creating your own program using fast machine language graphics are as follows:

- 1. Draw a representation of your selected characters, using the characters in the Graphics Reference Manual as elements.
- 2. In an equivalent number of spaces, enter the offsets of the screen address, starting at a point above and to the left of the figures. If the number of the offset exceeds 253, just split the figure into two or more parts and treat each as a separate entity. They can be

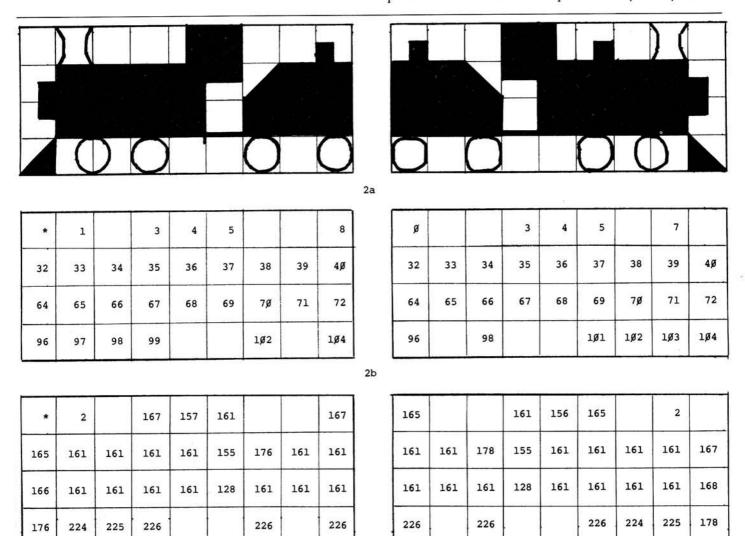


Figure 2. Graphics development

recombined in the BASIC program.

- 3. Likewise, enter the graphics character codes in the equivalent spaces on the grid.
- 4. Create a table which starts with the screen location of the figure (lo byte first, then hi byte); contains, alternately, the offset and code of each character; and ends in #254 or 255. If the figure ends in 254, the subroutine will continue with the next figure in the table. A #255 terminates the subroutine and returns to BASIC.
- 5. Note the starting addresses of each figure, for later use in creating the animation in BASIC.
- 6. Convert both the subroutine and the table into DATA statements. Note that if the table goes past memory location #608 + 144 (#752), it will be necessary to move all or part of it to another location in RAM, such as top of memory.
- 7. Finally, enter the DATA statements and their POKE loops into an appropriate location in your BASIC program, in a manner similar to lines 100-199 of Listing 2. Then procede with animation as in lines 25-99.
- 8. Debugging hints: always save to tape as you go (a program crash is more likely in machine language, and all that tough typing will be lost); insert a BREAK after DATA loops, then use the Monitor to verify

the machine language program entry, by single stepping starting at address \$0222; insert timing loops at lines 22, 27, 32, and 37 to slow down action if there is a Bug in BASIC.

#### Some additional notes

Another interesting program I've written using this method is Six Gun Shootout. It has two gunfighters (one facing the other) and three cacti. After each shot, the cacti change locations at random. The program ran very slowly when written solely with BASIC POKE's to the screen, but is as fast as you would ever want with machine language graphics. I'll cover this program in a later article, together with instructions for attaching simple up-down-shoot joysticks to save wear and tear on the keyboard.

Listi	ng 2.	Graphi	cs Tal	ble														
Ø26Ø	9B D	1 6ø8	155	2Ø9	Ø28A	46	Al	65Ø	7Ø	161	Q	82B3	25	Al	691	37	161	
Ø262	øl ø:	2 61ø	1	2	Ø28C	47	Al	652	71	161	g	Ø2B5	26	Al	693	38	161	
Ø264	Ø3 A	7 612	3	167	Ø28E	48	Al	654	72	161	g.	32B7	27	Al	695	39	161	
Ø266	Ø4 91	614	4	157	Ø29Ø	6ø	вø	656	96	176	g	Ø2B9 .	28	A7	697	40	167	
Ø268	Ø5 A	1 616	5	161	Ø292	61	ЕØ	658	97	224	ý	2BB	4ø	Al	699	64	161	
Ø26A	Ø8 A	7 618	8	167	Ø294	62	E2	66ø	98	225	g	2BD	41	Al	7Ø1	65	161	
Ø26C	2Ø A	5 62ø	32	165	Ø296	63	E2	662	99	226	ş	Ø2BF	42	Al	7Ø3	66	161	
Ø26E	21 A	1 622	33	161	ø298	66	E2	664	1ø2	226	ķ	Ø2C1	43	8Ø	7Ø5	67	128	
Ø27Ø	22 A	1 624	34	161	09A	68	E2	666	1Ø4	226	R	12C3	44	Al	7Ø7	68	161	
Ø272	23 A	1 626	35	161	Ø29C	FF		668	255		Q	12C5	45	Al	7Ø9	69	161	
Ø274	24 A	1 628	36	161	Ø29D	83	D1	669	131	2Ø9	Q	1207	46	Al	711	7ø	161	
Ø276	25 91	B 63Ø	37	155	Ø29F	øø	A5	671	ø	165	Q	1209	47	Al	713	71	161	
Ø278	26 B)	ø 632	38	176	Ø2A1	øз	Al	673	3	161	g	32CB	48	A8	715	72	168	
Ø27A	27 A	1 634	39	161	Ø2A3	ø4	9C	675	4	156	Q	2CD	6ø	E2	717	96	226	
Ø27C	28 A	1 636	4ø	161	Ø2A5	ø5	A7	677	5	165	Q	32CF	62	E2	719	98	226	
Ø27E	4Ø A	6 638	64	166	Ø2A7	ø7	Ø2	679	7	2	g	32D1	65	E2	721	1Ø1	226	
ø28ø	41 A	1 64ø	65	161	Ø2A9	2ø	Al	681	32	161	g	32D3	66	ЕØ	723	1Ø2	224	
Ø282	42 A	1 642	66	161	Ø2AB	21	Al	683	33	161	g	32D5	67	El	725	1Ø3	225	
Ø284	43 A	1 644	67	161	Ø2AD	22	В2	685	34	178	g.	\$2D7	68	B2	727	1Ø4	178	
Ø286	44 A	1 646	68	161	Ø2AF	23	9B	687	35	155	g	72D9	FF		729	255		
ø288	45 8	ø 648	69	128	Ø2B1	24	Al	689	36	161								
. 0000000000	- SACRE 5045				35925-45		Tillian.											

#### OSI

#### SOFTWARE FOR OSI

#### osi

#### We Have Over 100 High Quality Programs For Ohio Scientific Systems

#### ADVENTURES AND GAMES

Adventures - These interactive fantasies will fit in 8K! You give your computer plain english commands as you try to survive.

#### ESCAPE FROM MARS

You awaken in a spaceship on Mars. You're in trouble but exploring the nearby Martian city may save you.

This is a cruise you won't forget - if you survive it!

Adventures \$14.95 Tape or 51/4" Disk \$15.95 8" Disk

STARFIGHTER \$5.95

Realtime space war with realistic weapons and a working instrument panel.

ALIEN INVADER 6.95 (7.95 for color and sound) Rows of marching munching monsters march on

TIME TREK \$9.95

A real time Startrek with good graphics.

BATTLEPAC \$17.95

For the battlebuff. Contains Seawolfe, Starfighter,

Bomber and Battlefleet.

And lots, lots, lots more!



These programs allow the editing of basic program lines. All allow for insertion, deletion, and correction in the middle of already entered lines. No more retyping.

C1P CURSOR CONTROL (Text Editor) \$9.95

Takes 166 bytes of RAM and adds, besides text editing, one key instant screen clear.

#### C2P/C4P CURSOR \$9.95

Takes 366 BYTES to add PET like cursor functions. Enter or correct copy from any location

SUPERDISK \$24.95 for 5" \$26.95 for 8"

Has a text editor for 65D plus a great new BEXEC\*, a renumberer, search, a variable table maker and Diskvu - lots of utility for the money.

We also have 25 data sheets available such as: IMPLEMENTING THE SECRET SOUND PORT ON THE C1P \$4.00

HOW TO DO HIGH SPEED GRAPHICS IN BASIC

HOW TO READ A LINE OF MICROSOFT \$1.00 JOYSTICK INSTRUCTIONS AND PLANS FOR C1P \$3.00

SAVING DATA ON TAPE \$4.00

THE AARDVARK JOURNAL

A tutorial bimonthly journal of how to articles

Our \$1.00 catalog contains a free program listing, programming hints, lists of PEEK and POKE locations and other stuff that OSI forgot to mention and lots more programs like Modem Drivers, Terminal Programs, and Business Stuff.

Aardvark Technical Services 1690 Bolton, Walled Lake, MI 48088 (313) 624-6316

## Good News For **OSI Readers**

As you may have read by now, the Editor's Notes in this issue announce the merger of COMPUTE and compute II into one, high quality, monthly magazine.

Given the range of OSI products, we've decided to move you out of the Single-Board Computer Gazette, in the new COMPUTE!, and establish an OSI Gazette.

We expect to be assisted in this endeavor by your continued input. Articles and programming notes should be addressed to:

The Editor, COMPUTE!. P.O. Box 5406, Greensboro, NC 27403 ATTN: OSI Gazette

Given your input, we'll have a healthy, OSI Gazette. Robert Lock

## Modification and Relocation of FOCAL 65-E Into Erasible Prom

William C. Clements, Jr.
Dept. of Chemical & Metallurgical
Engineering
The University of Alabama
P. O. Box 2662
University, Alabama 35486

After using FOCAL for awhile, I became interested in storing the machine code in EPROM. Not only would this eliminate much of the waiting for tapes to load, but more important, it would free over 5K of user RAM for other purposes such as storing more FOCAL source code and variables, or for graphics routines.

The relocation of FOCAL and execution of it from PROM is not as straightforward as for some other programs, because the machine code is self-modifying in several places. Also, there are multitudes of data bytes used for address pointers scattered through the program, and these are in such a form that the ordinary kind of relocation routine would not convert them. Thanks to the excellent documentation supplied with FOCAL, I was successful in relocating it in a "clean", non self-modifying form. The code, together with an initialization routine that sets up page zero and other RAM locations used for user statements and to make the code "clean", fits neatly into three 2716's with plenty of room left over for other modifications such as tape load and save, "user" function, etc., which I have added to my version of FOCAL as well. The modifications which follow are concerned with cleaning the code up for storage in PROM, and pertain to FOCAL 65-E for the KIM-1, obtained from the 6502 Program Exchange in Reno, Nevada.

The first order of business in preparing FOCAL for PROM is to get rid of the self-modifying parts. The three places I found where FOCAL modifies itself in the main code are at locs. \$2348-2353, \$282C-283D, and \$3408-3414. A fourth place occurs in page zero, where it doesn't matter since page zero is always RAM in 6502

systems. The other places are easily fixed. I borrowed a few locations from an obscure corner of KIM's on-board RAM to do it; neither KIM nor FOCAL seems to mind. The changes are as follows:

2348 was 8C 52 23 change to 8C DE 17 STY DJADR
234E was 8C 53 23 change to 8C DF 17 STY DJADR + 1
2351 was 4C 00 00 change to 4C DD 17 JMP \$17DD
282C was 8C 3C 28 change to 8C DB 17 STY DJADR1
2835 was 8D 3D 28 change to 8D DC 17 STA DJADR1 + 1
283B was 6C 00 00 change to 4C DA 17 JMP \$17DA
3408 was 8E 12 34 change to 8E E1 17 STX MOV11
340C was 8C 14 34 change to 8C E3 17 STY MOV22 + 1
3411 was B5 00 change to 4C E0 17 JMP MOVIT
3413 was 95 00 change to EA NOP

Additional code needed in page 17 is:

17DA 6C 00 00 JMP (0000) 17DD 4C 00 00 JMP 0000 17E0 B5 00 MOVIT LDA(X) 00 17E2 95 00 STA(X) 00 17E4 4C 15 34 JMP 3415

The address overwriting now occurs in page 17 RAM instead of in the main code, which can now be safely put into PROM.

Before doing so, however, we must relocate it. Note that relocation should not alter existing page boundaries (see warning on p. 44 of FOCAL 65-E Manual). This actually makes the job easier, because only the high-order bytes of addresses and addresswords can be changed. Relocation then is accomplished by (a) adding the desired offset to the third byte of all three-byte instructions which do not reference page zero; (b) Offsetting the data words for routines such as PUSHJ and POPJ, the software stack manipulators. These words are scattered here and there through all the code. A listing of their high-order halves is given in Table 1; they are address words, so only the second byte is to be offset. (c) Offsetting the high-order bytes of the address tables at the end of the FOCAL code, which are at hex locs. 34FA-3515, 3546-3557, 356A-356E, 3598-359C, 35A2-35A6, 35AC-35B0, 35B6-35BA, 35C0-35C4, and 35CA-35CE. (d) Adding the offset to the IRQ-vector initialization byte at loc. 34AE (I date your cleverest relocation program to find that one!).

A final change necessary to execute FOCAL from PROM is to change the RAM allocation for program statements and variables so it is located in RAM, instead at the end of the machine code to go in PROM. The original start of this allocation is at loc. 35F3, but if you are going to PROM your FOCAL I suggest you save some PROM locations by deleting the heading that is printed as if it were line number 00.00 by the Write command. I retained only the line number zero and a carriage return in my version, since the program expects to print something there. This saves twenty-seven bytes of memory. In my system, I decided to start the RAM storage for statements and data at loc. 4000, so initialization there is as follows:

<sup>1</sup>See 6502 User Notes, issue #16, and errata in issue #17.

4000 00 ;line number 4001 00 ;of 00.00 4002 0D ;ASCII 'CR' 4003 FE ;PBEG 4004 FF ;VEND

To tell FOCAL where to put its statements and variables, some page zero locations need to be changed:

002F was D4 35 change to 00 40 ; beginning of RAM allocation 0031 was F2 35 change to 03 40 ; start of user's text 003E was F3 35 change to 04 40 ; start of variable list 0040 was F3 35 change to 04 40 ; start of variables for "ease all" 0042 was F3 35 change to 04 40 ; end of variable list

The code to accomplish page zero and page 17 setup and initialize the user RAM is given in Table 3. The code begins at loc. 3677 instead of right after the FOCAL code because I have some other modifications in between; the user will want to relocate this to suit his system anyhow.

Table 1. Table of High-Order

Data Bytes Used by POPJ and PUSHJ. Add Offset to Relocate.

Table 2. FOCAL Initialization

011000							
Hex Location	Original Contents	3677	A2 00		COLDST	LDX \$00	;Initialize table & instructions
		30	BD AO	36	LOOP1	LDA(X) TABL1	;at page zero
2088	23		95 20	30	10011	STA(X)	,
20B2 20D7	23		E8			INX	
20D7 212F	29		EO BD			CPX \$BD	;Initialize \$17BA-\$17E6 for
	21		DO F6			BNE LOOP1	;removal of self-modifying code
219E	21		A2 00			LDX \$00	;in FOCAL
21DO	23		BD 5D		LOOP2	LDA(X) TABL2	,III FOCAL
21FE	23		9D DA		HOOLE	STA(X) \$17DA	
2440	2B		E8			INX	
2452	29		EO OD			CPX \$0D	
24BB	29		DO F5			BNE LOOP2	;Initialize User RAM
2502	2B	3690	A2 00			LDX \$00	;with line number
2516	29	3070	BD 6A	37	LOOP3	LDA(X) TABL3	;zero and data bytes
2533	29		9D 00		10013	STA(X) \$4000	,zero ana data bytes
2546	29		E8	40		INX	
256A	29		E0 05			CPX \$05	
257A	23	1	DO F5			BNE LOOP3	;Go to FOCAL cold start
25EB	29	369D	4C 00	20		JMP FOCAL	;page zero constants & code
29DC	29	36A0	conte		of o	JPIF FOCAL	
29E5	2D	30A0			s. \$0020-{	TABL1	
2A45	2B	1	(\$00DC				Table for march or to
2A5D	29	2750	( SOODC	go	nere /		;Table for patches to
2ABE	29	375C	(0.00	00	TABL2		;remove self-modifying
2B97	29	375D	6C 00		TABLZ		;code in FOCAL
2EFF	29	4	4C 00				
2F7F	29		B5 00				
2FA3	29		95 00				;Line no.
2FE8	29	0671	4C 15	34	m. n. n		
300D	2B	367A			TABL3		;of 00.00
309E	29		00				;ASCII 'CR'
316A	2B		OD				;PBEG
3186	29		FE				;VEND
31A8	21	367E	FF				
34AE	2C						0
		10					

 $\mathcal{D}$ 

## COSMAC QUICKIES Jess Hillman

Quick, inexpensive solutions to control problems are always desirable, so owners of COSMAC Elf microcomputers may find many interesting ways to use the "quickie" programs in listings one, two and three accompanying this article.

The programs were written specifically for my Ouest Super Elf, which has 4.25K RAM, but they should run with very little tweaking on any 1802-based system, if entered beginning at any

quarter-K page boundry.

Listing one is an interval timing program that can be set for any delay from a couple of seconds to about ten minutes by varying only the data byte in location 0011. By changing the program beginning at location 0015 to read: "9F FB XX (any value from 00 to FF) CE 30 05 7B 30 00" the program can set intervals up to two days (actually the maximum value for Register F falls a few minutes short of 48 hours). The data bytes in locations 0011 and 17 set the final value selected. Since the 1802 has plenty of registers for such usage, it would be very easy to establish intervals months long.

The program specifically uses Register E, one of the 1802's sixteen, sixteen-bit general purpose registers, as a timer that continually counts down from hex FFFF. When Register E reaches zero, a fact discovered by testing both high and low bytes, Register F is incremented by one. The F register is then tested to see if the predetermined value has been set. If not, the timing loop continues.

Once the proper value for F has been reached, the 1802 sets its Q line, an external flag that can be set or reset depending on various internal conditions of the processor, to a logic "1." After thus acknowledging it has reached the required time, the Q line is reset to logic zero and the timer resumes its labors. The Q line transition can be latched by connecting it to an integrated circuit such as the 74LS175 or the CMOS 4016, and held for use in driving a transistor, opto-isolator or relay (for highvoltage uses) to operate a coffee pot, television, stereo--practically anything controllable with an electronic switch.

Newcomers to the 1802 be warned: when tying to the Q line always buffer it generously with an IC like the 4050 or 4049, either of which can drive two TTL loads. Otherwise, you risk ruining your

microprocessing chip.

A variation of this use of the Q line is found in listing two, in which the operator wishing access to the Q line must first enter three predetermined, twohex-digit numbers into memory in the proper sequence. That oughta keep Pop's pet project safe from the kids!

As the data bytes for the "combination" are entered into memory, the 1802 performs a logical exclusive or with each byte in turn, using data stored at addresses 000D, 0017 and 0021 respectively. If the wrong number is entered at any point, the program jumps to the error subroutine beginning at location 0030, which momentarily outputs an "EE" to the data display (I have seven-segment LEDs) while executing a three-second timing delay, then outputs a "00" to the data display and jumps back to the beginning of the program.

In listing two, once the proper number sequence has been entered, the Q line goes high and stays that way until the input key is pressed and released (or external data flag EF4 is otherwise pulled low). Once EF4 goes low and returns to its normal state, Q goes to logic zero and the program loops back to the

beginning again.

As written, you would have to enter 05 (at 0D), 17 (at 17) and 98 (at 21) to turn the Q line from logic low to logic high. You can change the data bytes for any combination you wish. The chances of someone solving the combination decrease if you add more numbers to the combination.

Listing three changes this program to utilize an output port and eight data bits to control various devices. When entered as listed and run, the program will: require you to enter the three number combination properly, after which the Q line goes high (on my system this turns on an LED); then you must enter a status byte which will be put in the memory stack and also latched into the output port (1802 output instructions are 6N, where N designates a port from one to seven). I use a 63 instruction because that port is readily available on my Elf's expansion board. Once the status byte has been latched to the output port, the program loops back to the beginning of memory and starts again.

The status byte can be whatever you want it to be, depending on your interface configuration. Eight data lines are immediately available, so using transistors, relays or a combination of techniques can give you immediate computer control of the major energy consuming devices in your home--air conditioning, hot water heater, and so on.

By expanding the interval timer to include a lookup table of status bytes for dispatch to the output port at various times of the day, automatic control your home's major functions becomes possible. The only question you must answer is how elaborate you want it to be.

Using the upper four bits of the status tied to, say, a 74LS154 four-to-sixteen line decoder, with the lower four bits or-tied to sixteen latches like the 74LS175, it would be possible to control up to sixtyfour devices from your micro's output port.

Possible expansions and combinations of these programs are virtually endless. As quickie programs go, however, they should give newcomers to the

1802, or people struggling with a system they've had for a time, a feel for register manipulation and con-

trol application possibilities of the typical COSMAC system.

Listing 1	Address	Data	Mnemonics	Comments
Interval Timer	0000	F8 00	LDI 00	Initialize Reg. F for
	02	AF BF	PLO, PHI	use as workspace
	04	7A	REQ	Make sure Q is at logic "0"
	05	2E	DEC R.2	Decrement timer
	06	9E CE	GHI, LSZ	Check timer, long skip if zero
	08	30 05	BR 05	If not zero, continue loop
	0A	8E CE	GLO, LSZ	If high byte zero, check low byte
	0C	30 05	BR 05	If not zero, continue loop
	0E	1F	INC Reg. F	If low byte zero, increment workspace register by one
	OF	8F	GLO R.F	Get new value from Register
	10	FB 17	XRI 17	Exclusive Or with predetermined value
	12	CE	LSZ	If values match, long skip (PC incremented by 2)
	13 15	30 05 7B	BR 05	If no match, continue loop
	16	30 00	SEQ BR 00	Set Q line at logic "1" Then start looping again
	17	00	IDL	End
Listing 2	Address	Data	Mnemonics	Comments
Combination	0000	F8 00	LDI 00	Set up workspace in memory
Lock	02	B4	PHI	using Reg. 4 to point to
LUCK	03	F8 F0	LDI F0	stack beginning at
	05	A4	PLO	address 00F0
	06	E4	SEX	
	07	3F 07	BN4 07	Loop if EF4 equals zero
	09	37 09	B4 09	Loop if EF4 equals one
	0B	6C	INP 4	Get keyboard byte
	0C	FB 05	XRI 05	Check if correct combination #
	0E	CE	LSZ	Long skip if zero (a match!)
	0F	30 30	BR 30	Else go to error subroutine
	11	3F 11	BN4	Wait until next byte latched
	13	37 13	B4	in from keyboard
	15	6C	INP 4	get the byte
	16	FB 17	XRI 17	If it matches, too, then long skip
	18 19	CE 30 30	LSZ BR 30	Go To error subroutine otherwise
	19 1B	3F 1B	BN4	If second number matches, wait
	1D	37 1D	B4	for last combination number
	1F	6C	INP 4	Get it
	20	FB 98	XRI 98	See if it, too, matches
	22	CE	LSZ	Long skip if it does
	23	30 30	BR 30	Error subroutine if it doesn't
	25	7B	SEQ	All numbers OK, Q equals "1"
	26	3F 26	BN4	Keep Q line on until input
	28	37 28	B4	key pressed and released
	2A	7A	REQ	Then turn it off and go back
	2B	30 00	BR 00	to beginning
				Error subroutine
	30	F8 EE	LDI EE	Load message "EE"
	32	54	STR	store it in stack, then
	33	64	OUT 4	output to LED display port
	34	$\mathbf{BF}$	PHI Reg. F	Also store in Register F
	35	2F	DEC Reg. F	Reg. F decremented by one
	36	9F	GHI	Check byte in Reg. F
	37	CE	LSZ	Skip next two bytes if zero
	38	30 35	BR 35	Otherwise loop
	3A	F8 00	LDI 00	Load "00" and output to
	3C	54	STR	clear error message from
	3D 3E	64 30 00	OUT 4 BR 00	display Go back and try again
Listing 3	Address	Data	Mnemonics	Comments
Controlling	002A	6C	INP 4	Get the byte input after correct combination given
multiple devices	2B	54 63	STR	Put status byte in stack
	2C 2D	7A	OUT 3 REQ	Output status byte to device interface Turn Q off
	2E	30 00	BR 00	
	-13	30 00	DICOO	Then go back to start

## The 1802 Instruction Set

Dann McCreary Box 16435 San Diego, CA 92116

In case you missed our first column, we took a flight of fancy over the 1802 to survey it's architecture. With this installment we begin a leisurely look at the 1802s' instruction set. Where possible, we'll try to compare and contrast 1802 instructions with similar instructions on the 6502.

Before we get rolling, here's an interesting bit of news I got from a certain OEM user of the RCA 1802. They have been delivering 1802 based systems which run at a clock rate of 3.2 MHZ. The systems were designed well within RCA's specs for the 1802. They are real-time systems and much of the software developed for them depends on that clock rate. Well, it seems that RCA has since had second thoughts about their 1802 speed spec. They've notified their customers that the 1802 is now only useable at up to 2.5 MHZ. Not nice! If any other 1802 users out there feel like victims of the "sting", I'd like to hear about it.

Do you remember the 1802s' I and N registers? A large number of 1802 instructions can be readily understood by breaking them down into their I and N components. Generally speaking, the contents of I determine the operation to take place, while the contents of N designate the general purpose 16 bit register to be used or affected. Look at the illustration of the instruction matrix. Each unbroken horizontal area represents an instruction of this type. Even the LDN instruction in the first row is like this except that it is not applicable to R0, since the 00 hex op-code has been preempted for use as the IDL instruction.

Let's take for example a 1C hex. The 1 in the I register says that this is an increment instruction and the C in the N register says that it is to affect RC, one of the 16 bit registers. You could change this to affect any register merely by changing the N portion of the op-code. (By the way, this kind of consistency across the board makes the 1802 one of the easiest processors to hand assemble code for.) INC performs a true 16 bit increment with rollover such that FFFF hex increments to 0000 hex. It is very much like the 6502s' INX and INY instructions except that X and Y are only 8 bit registers. One caution: since the 1802 has no status register, the only way to branch on the result of an INC is to test the register contents by moving them in to the 1802 accumulator, register D. Also note that the 6502 INC lets you increment memory contents but the 1802 INC is strictly for registers. These comments apply as well to the DEC

instruction, 2N hex (where N represents any hex digit), but in the opposite direction.

On the 6502 you can load the accumulator (LDA) from memory using a variety of addressing modes. The 1802 gives you LDN (0N hex) which lets you load D with the contents of a memory location, and LDA (Load Advance, 4N hex) which is a LDN and an INC rolled into one. But which memory location does the data come from? The contents of the register designated by RN go out on the address bus, selecting a memory location. Right there, my friend, is what can be one of the more frustrating aspects of programming an 1802 - the only way to access memory is via a register. This implies doing some LDIs (Load Immediates, identical in function to the 6502 Immediate Mode) to set up a memory address. Compare these:

6502

AD 3412 LDA ADDR1 .. READ MEMORY 1802

F8 12 LDI A.1 (ADDR1) .. SET UP B8 PHI R8 .. R8 TO POINT TO F8 34 LDI A.0 (ADDR1) .. THE DESIRED AQ8 PLO R8 .. MEMORY ADDRESS 08 LDN R8 .. READ MEMORY

Looks pretty bad for the 1802, right?
Well, consider that every time you want to load or store at that memory location with a 6502 it's going to take 3 BYTES. On the 1802, once you've set up the address you can load or store (STR) with only one BYTE. The 1802 LDA instruction also gives you 16 bit auto-indexing memory access with a one BYTE instruction! To do this on the 6502 you would have to set up two page zero memory locations with the starting address and then do a double-precision increment between each memory access. I'll let you figure out how many BYTES that would take you!

In our example we also used PHI and PLO. These instructions transfer the contents of the accumulator, D, to the high or low order BYTE of the register designated by N (RN). The converses of PHI and PLO are GHI and GLO. GHI transfers the most significant BYTE of RN to D. GLO transfers the least significant BYTE of RN to D.

The last two instructions that operate consistently across the board are SEP and SEX. SEP simply takes the contents of N and places them in the P register. You may recall that the 4 bit P register determines which 16 bit register is the current program counter. At system reset, P is forced to zero, making R0 the initial program counter. After initializing some registers, a program might execute a SEP instruction as a simple means of transferring to a subroutine. Let's consider a subroutine with the simple task of toggling the Q flip-flop from its present state to the opposite state. We'll assume that our main program is using R0 as program counter and that the subroutine will be at 1101 hex. Before we can use the subroutine, we must put its' starting ad-

dress into a register like this:

F8 11 LDI A.1(QSUB) .. MSB OF ADDRESS B7 PHI R7 .. INTO R7.1 F8 01 LDI A.0(QSUB) .. LSB of ADDRESS A7 PLO R7 .. INTO R7.0

The .1 and .0 notations indicate HI and LO order portions of a register or 16 bit address. Now we can execute this:

#### D7 SEP R7 .. GO TO QSUB

When the SEP R7 is executed, R0 is left pointing at the instruction immediately following the SEP R7. So can you guess what dur return from subroutine instruction will be? Right, a SEP R0! Here's QSUB:

1100

DO QRET: SEP RO .. RETURN TO MAIN PROGRAM CD QSUB: LSQ .. IF Q IS SET, SKIP 2 BYTES

7B SEQ .. SET Q

38 NBR .. SKIP A BYTE

7A REQ .. RESET Q

30 00 BR QRET .. GO RETURN

Why is the return at the top? After executing QSUB and branching to QRET, the last thing the subroutine does is execute the SEP R0. As that is executed, R7 is incremented and now points once again to QSUB, ready for the next subroutine call. Please note that only programs using R0 as their program counter may call this subroutine. Incidently, we used some new instructions here - SEQ and REQ which are considered control type instructions and some branch and skip instructions. The branch instructions are the unconditional branch, BR, and the unconditional branch not, NBR. Unlike the 6502 which provides relative branching, the 1802 only permits absolute branching. Its short branches are much like a 6502 IMP instruction, only the high-order address is whatever is currently in the program counter. Thus you can only do a short branch within the memory page you are already on. Also, when you relocate code in memory, most of the branch addresses must be changed - quite tedious if you are assembling the code by hand. The 1802 does allow unconditional short branches, something that sure would be nice to have on the 6502. The NBR instruction is interesting because it effectively results in a skip and in fact you may wish to use the mnemonic skip rather than NBR. Conditional branches are possible based on the state of Q or DF and also on the zero/non-zero state of D. This includes both short and long branches. The long branches are like the jump on the 6502 but if you are assembling by hand, beware! All 16 bit addresses on the 1802 are specified in normal order, not reversed as on the 6502. Conditional short branches are also possible based on the state of the external flag lines, EFI-EF4. As an exercise, try writing a subroutine that returns a number from 1 to 4 in D, based on which one of four external flag lines is activated. Use the instructions B1, B2, B3, and B4 to branch on the state of the flags.

### 1802 INSTRUCTION MATRIX

N
0 1 2 3 4 5 6 7 8 9 A B C D E F

	0	LOAD VIA RN (LDN)												
	1	IN	CREMENT	RN (INC)	)									
	2	DECREMENT RN (DEC)												
Ì	3	BRANCH BRANCH BRANCH NOT ON Q, Z, DF ON EF1-EF4 ON Q, Z, DF ON EF2												
	4	LOAD-ADVANCE RN (LDA)												
Ī	5	STORE VIA RN (STR)												
	6	R OU	TPUT	INPUT										
[	7	CONTROL & MEMORY REI	ARITHMETIC W/CARRY	CONTROL	ARITH. IMMEDIATE W/CARRY									
	8	GET LOW BYTE OF RN (GLO)												
	9	GET HIGH BYTE OF RN (GHI)												
	A	SET	LOW BYTI	E OF RN (	PLO)									
	В	SET	нісн вут	E OF RN	(PHI)									
	$\mathbf{c}$	LONG BRANCH	O LONG SKIP	LONG BRANCH	LONG SKIP									
	D	S	ET P REGI	STER (SE	<b>P</b> )									
	E	SI	ET X REGI	STER (SE	X)									
	F	LOGIC	ARITHMETIC	LOGIC IMMEDIATE	ARITHMETIC IMMEDIATE									

The LSQ in our example is typical of the Long Skip isntructions. If the condition of the skip is met, the next two bytes are skipped. Otherwise, execution continues with the next instruction. Long Skip conditions are the same as for Long Branches, with the addition of LSIE which permits testing the state of the interrupt enable flag, IE.

Finally, we come to the instruction we've all been waiting for- SEX! Obviously the designers at RCA are not your staid, single-minded, no-nonsense engineering types at all. They appear to enjoy mixing a little fun in with their work! Setting X, from which the infamous mnemonic is derived, simply puts the value of N into the X register. A number of the instructions we have yet to look at interact with the memory location pointed to by the 16 bit register designated by X. We'll refer to that register as RX.

LDX is like LDN. It loads the contents of memory pointed to by RX into D. LDXA is to LDA as LDX is to LDN. STXD is like a STR, but instead of storing D via RN, it stores D at the location pointed to by RX and decrements RX to boot. Now if they had only included a load via X and decrement, and a store via X and advance (LDXD & STXA) the 1802 would have been much more versatile! Oh, well. So much for memory reference via RX.

The 1802 gives you a handful of arithmetic operations that let you subtract or add the contents of memory and D. Unlike the 6502, the 1802 gives you the option of excluding the carry (DF) from the operation. Thus, you can add without first clearing the carry and subtract without first setting the carry. Arithmetic can also be done using the immediate byte, allowing you to add or subtract fixed values.

The logical operators used VIA RX are AND, OR and XOR (Exclusive OR). They work much like their 6502 counterparts. They may also be used in immediate mode. D may be operated on also with the SHR, SHRC, SHL and SHLC. These are identical to the 6502 LSR, ROR, ASL and ROL commands, in that order except that they apply only to shifting the accumulator.

Input and output instructions are also intimately

## While They Last!

Blank board for EP-1 EPROM
PROGRAMMER, only \$19, complete with software and over 20 pages of documentation! Programs, verifies, copies, 2708, TMS 2716, 2716, 2732 etc. Use with KIM, SYM, AIM, PET, etc. Needs 12 ports.

EE-1 Emulates EPROM for speedy hardware and software development. Send S.A.S.E (284)

NIAGARA MICRO DESIGN, INC.

for quick information.

1700 NIAGARA ST. BUFFALO, N.Y. 14207, 716-873-7317

related to RX. To output a byte of data, you must first store it at the memory location pointed to by RX. RX is also incremented when the OUT is executed, making this handy for outputting messages from buffers. Using INP inputs a byte into D, but be careful! It also gets stored VIA RX. Be sure RX is pointing where you want it. When doing an Input or Output, the N lines on the 1802 chip are set to match bits 0, 1 and 2 of the contents of the N register. This makes I/O decoding in hardware somewhat simpler than the 6502 memory-mapped only approach.

IRX increments the X register. It is really a vestigial out instruction but no output is defined when N = 0. Note also that what might have been an INP 0 (68 HEX) is the one undefined 1802 opcode. It is now used on the recently released 1804 to add some features and correct some 1802 deficiencies.

Well, we've looked over all but a handful of the 1802's 255 instructions. All that are left are some control instructions with some relatively obscure or involved applications. We'll discuss them in later columns as we apply them. Meanwhile, try converting some 6502 code into 1802 code for practice. And let me hear some comments! I can be reached at Box 16435, San Diego, CA 92116.

## 1802 SOFTWARE

BIORHYTHMS \$12.95 SLOT MACHINE \$ 9.95 BLACKJACK \$ 9.95 OTHERS

**S.A.S.E.** for information. Will work on any 1802 system with terminal and 4K memory. Written in machine language by L. Sandlin.

ELF II cassette and listing. Texas Residents add 6% Sa. Tx.

SANSOFT PLUS PO BOX 58170 Drawer 900 Houston, Texas 77058

C.O.D. after 6PM (713) 488-7905

## **CAPUTE!**

## **Our Bug-Box**

#### Robert Lock

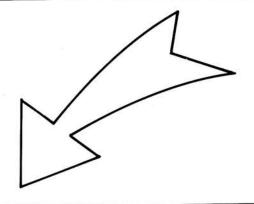
Here, at long last, are the corrections to **Read Pet Tapes With Your Aim** that appeared in the March/
April issue (#3) of COMPUTE.

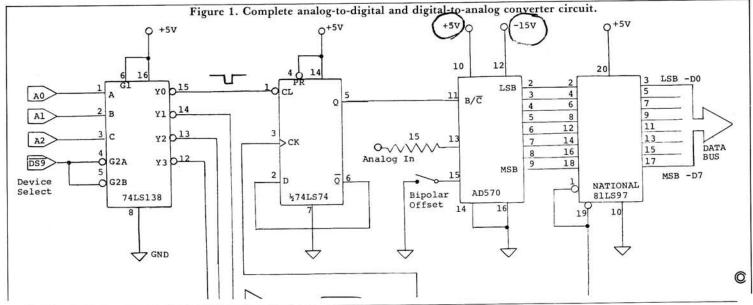
LINE	# LOC		CO	Œ	LINE				
0041	0212	D0	F6			ENE	NEXT		
0043	0214		89	03			OFFON	TURN OFF TAPE	
0044	0217		0.0	120120			#00	COUTPUT NAME OF FILE	
0045	0219			04	NAME		FILEYX		
0046	0210		20			CMP		LOOK FOR BLANK AT END	
0047	021E		0.6				LEN		
0048	0220		$Z\Delta$	19			OUTPUT		
0049	0223	E8	j /			XXX	N. 6 N. 622	A 20, poster a company of the compan	
$0050 \\ 0051$	0224		F3	E8	LEN		NAME BLANK	GET NEXT LETTER	
0001	O Zi, Zi, Ci	x U	A.D.E.,	i::. (C)	LE.1X	Car	Edministry		
0053	0229	18				CL.C		OUTPUT NECESSARY MEMORY	
0054	022A	AD	60	04			END	FOR PROGRAM	
0055	0220	69	62			ADC	#\$62	ADD TO END	
0056	022F	CB CIB	60	04		STA	END	THE DIFFERENCE BETWEEN PET	AND
0057	0232	AD	6E	04		L.DA	END+1	AIM BASIC START LOCATIONS	
0058	0235	69	0.0			ADC	#00		
0059	0237	20	46	EA		JSR	NUMA	FOUTPUT IT	
0060	023A	AD	60	04		L.DA	END		
0061	023D		46			JSR	NUMA		
0062	0240	20	3E	E8		JSR	BLANK		
0064	0243		73				REDOUT	GET A CHARACTER	
0065	0246		89	03			OFFON	ITURN ON TAPE	
0066	0249		59				# ' Y	FY MEANS READ THIS FILE	
0067	0248	F 0				BEQ		CONTROL CONTRO	
8600	024D		6A				FLAG	CHANGE FLAG'S VALUE	
0069	0250		13				CRLOW	Company of the Company of the Company of the Company	
0070	0253	40	0A	U X		OMP.	NEXT	FREAD NEXT FILE ON TAPE	
0072	0256	EΑ				NOP		FREMOVE IF USING	
0073	0257	EA				NOF.		AN ASSEMBLER	
	S = 00			0 >					
END O	F ASSE	MEIL.	(						

Note to you PET Owners who read COMPUTE. **Don't use** the Disk ID Changer program in Issue 5 until you see the **important** update in Issue 6. RCL

#### Oops!

And here's an important correction for Marvin L. DeJong's compute II, Issue 2 schematic. (Page 6, Some A/D And D/A Conversion Techniques. Note that pins 10 and 12 (circled) are now (correctly) reversed.





## **6502 FORTH**

- 6502 FORTH is a complete programming system which contains an interpreter/compiler as well as an assembler and editor.
- 6502 FORTH runs on a KIM-1 with a serial terminal.
   (Terminal should be at least 64 chr. wide)
- All terminal I/O is funnelled through a jump table near the beginning of the software and can easily be changed to jump to user written I/O drivers.
- 6502 FORTH uses cassette for the system mass storage device
- Cassette read/write routines are built in (includes Hypertape).
- 92 op-words are built into the standard vocabulary.
- Excellent machine language interface.
- 6502 FORTH as user extensible.
- 6502 FORTH is a true implementation of forth according to the criteria set down by the forth interest group.
- Specialized vocabularies can be developed for specific applications.
- 6502 FORTH resides in 8K of RAM starting at \$2000 and can operate with as little as 4K of additional contiguous RAM.

#### **6502 FORTH PRICE LIST**

KIM CASSETTE, USER MANUAL, AND COMPLETE ANNOTATED SOURCE LISTING \$90.00 (\$2000 VERSION) PLUS S&H 4.00

USER MANUAL (CREDITABLE TOWARDS SOFTWARE

TOWARDS SOFTWARE PURCHASE)

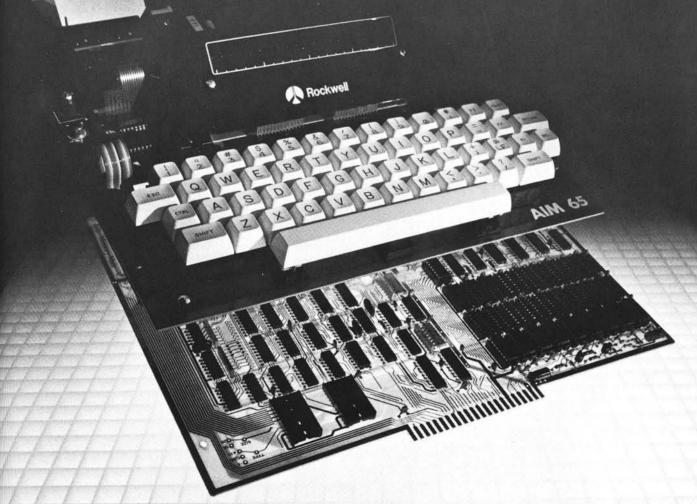
\$15.00 PLUS S&H 1.50

SEND A S.A.S.E. FOR A FORTH BIBLIOGRAPHY AND A COMPLETE LIST OF 6502 SOFTWARE, EPROM FIRMWARE (FOR KIM, SUPERKIM, AIM, SYM, and APPLE) AND 6502 DESIGN CONSULTING SERVICES AVAILABLE......

Eric Rehnke 1067 Jadestone Lane Corona, CA 97120

Now Available For KIM, AIM, And SYM

# Finally...Serious Expansion for the AIM-65



Introducing Memory-Mate\*, the AIM-65 expansion board that lets you spend your time on application solutions, not hardware hassles. Add Memory-Mate to your AIM-65 and make quick work of development and process control projects.

In its primary function, the Memory-Mate board provides 16-48K of RAM expansion assignable in 4K blocks anywhere in the system. Memory-Mate's parity check circuitry insures system RAM integrity (including AIM's 4K on-board RAM) for high reliability applications. The programmable write protect feature eases software development chores. This compact board, which fits directly **beneath** the AIM, also includes four programmable I/O ports, a tone generator for audible warnings, and sockets for 4K of PROM.

I/O intensive applications are accommodated with Memory-Mate's STD BUS interface option. Use off-the-shelf STD BUS cards to solve your biggest I/O problems.

The Memory-Mate with 16K RAM is priced at \$475, with 16K expansion chip sets (including parity chip) costing \$100 each. With 48-hour active burn-in and warranty for a full year, you won't have to worry about reliability either.

First of the complete AIM-Mate\* series, Memory-Mate will be joined shortly by the Video-Mate\*, Floppy-Mate\* and the AIM-Mate case. For further information on the entire AIM-Mate series, write 'Attn: AIM-Mate Series' at the address below.

\*TM Forethought Products

Forethought Products

87070 Dukhobar Rd., Eugene, OR 97402 (503) 485-8575 Introductory Special for Compute II Readers 16K Memory-Mate Board for \$399 thru Sept. 15! Call for details

## Low Cost Graphics Are Now Here

### Add Printable High Resolution (320 x 200) Graphics To Your AIM-65 Microcomputer

Visible Memory Board It's a reality. The Visible Memory and graphic print software from MTU are now available for the Rockwell AIM-65. The Visible Memory gives a high resolution 320 wide by 200 high bit mapped pixel display matrix. Each dot is individually addressable for maximum utilization and speed. Thus characters, image shapes, and graphs can all be displayed separately or simultaneously if needed - maximum flexibility for you.

The Visible Memory is just that, an 8K byte RAM board that contains 2 access ports to the memory matrix. The microprocessor bus uses one port and the display refresh circuitry uses the second port. The contents of the memory bit-for-bit is precisely what is displayed. If you need 8K of RAM for a non-display application, use it! It makes no difference to the board what its contents are; program (seen in its binary pattern form) or a human recognizable display pattern. The display refresh occurs at times when the processor never goes to memory. Therefore there is no snow on the display and no wait states for the processor.

Hardcopy Too In addition MTU has engineered a software package to drive the AIM-65 printer in new ways. Three new forms of printing are possible. QUICKPRINT gives a matrix 200 across by 320 up the 21/4" wide paper. QUALITYPRINT gives two prints, each 100 x 320 which gives a higher quality (41/2" wide) printed area when placed side by side. TEXTPRINT allows you to print the AIM text buffer area of memory as 10 rows of characters printed "up"

with hardcopy capability.

the paper strip. You may specify up to 127 characters per row for the row length. The QUICK and QUALITY print modes are designed to give you fast, easy hardcopy of the Visible Memory contents. Thus you now have a graphic computer

Graphic Text Software Drivers To allow you to easily use this graphic display and print power, MTU has also designed the K-1008-5C software package which gives you point plotting, line drawing, character generation and a host of other subroutines. Written in assembly language, these routines may be executed from BASIC or assembly language - your choice. Text output from BASIC or the AIM monitor may also be shown on the Visible Memory display as up to 22 lines by 53 characters per line significantly enhacing the use of the AIM-65 as a computer with a CRT display.

Call Us Now Many educators have been waiting for this type of price/performance to set up courses. MTU will be pleased to quote quantity purchases - call us direct now. Demand is high and Fall is just around the corner.

K-1008 Visible Memory	\$240
K-1008-5C Graphic/text software	\$25
K-1009-1C AIM Print software	\$25
K-1000-5 AIM-65 Power Supply	\$65
K-1005-A AIM-65 Card File	\$85
Many others not listed	

Call or write for our catalog listing all our AIM-65 (also our PET, KIM-1, and SYM-1) products.

As of June 1, 1980 place orders at: Micro Technology Unlimited, P.O. Box 12106, 2806 Hillsborough Street, Raleigh, North Carolina 27605





